The Engineer

NOVEMBER 6, 1953 28, ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS

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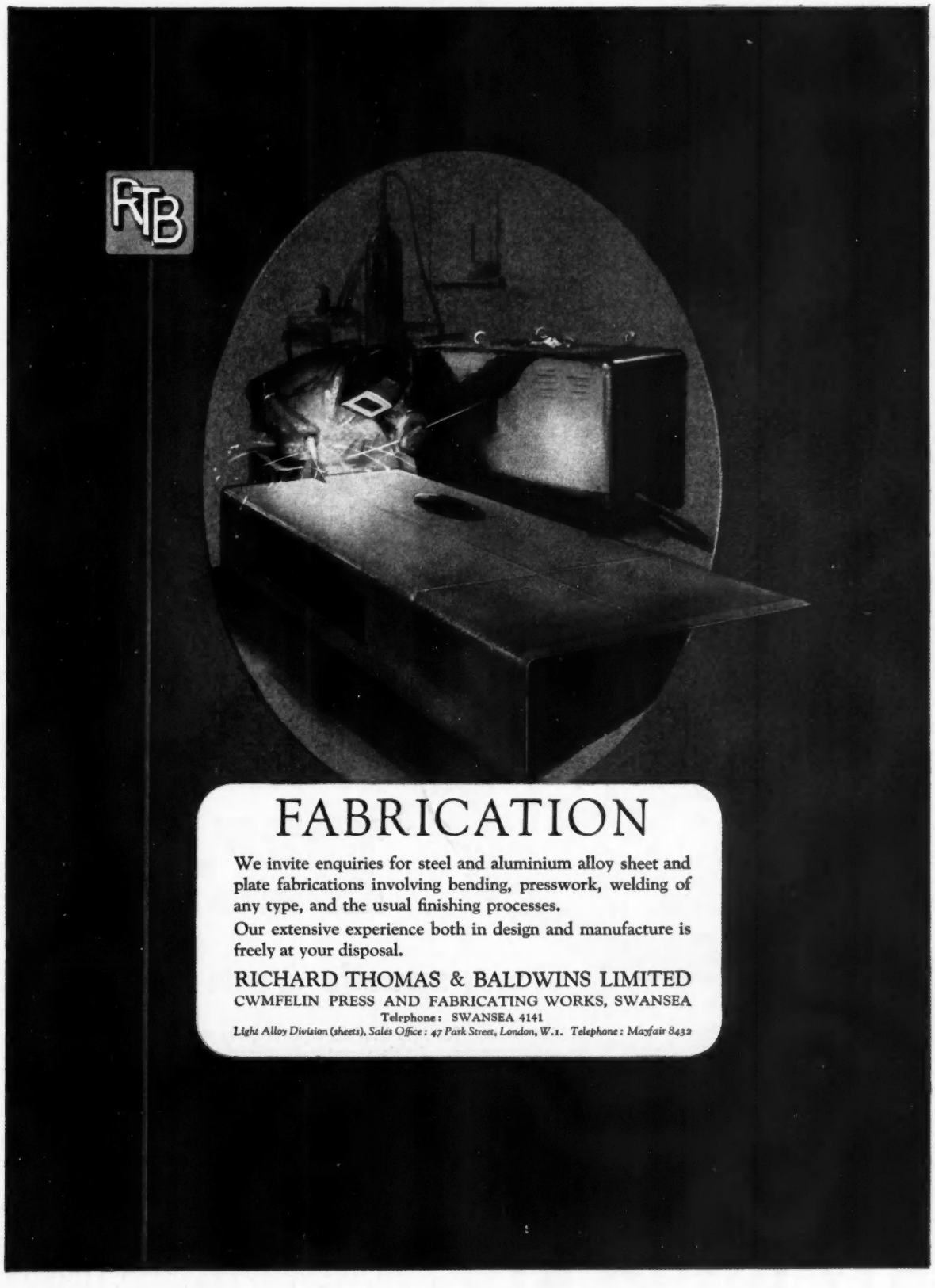

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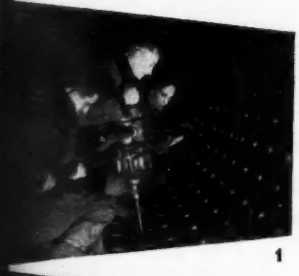
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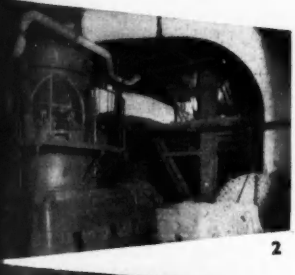
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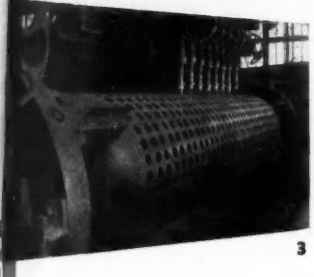
3

1. *Power expanding of tubes inside a boiler drum.*
2. *One of two Raymond Bowl Mills and exhauster fans firing one water-tube boiler.*
3. *Multiple spindle machine trepanning tube holes after fabrication.*

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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WORDING OF ADVERTISEMENTS: Approximately the firs. 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

THE UNIVERSITY OF MANCHESTER

DEPARTMENT OF ENGINEERING

DESIGN ASSISTANT

There is a vacancy for a DESIGN ASSISTANT in the Department of Engineering. Applicants must be capable of working up detailed design apparatus from sketch design to working drawing, preparing layout of drawings of laboratories, including services, and taking charge under a member of staff of the students' drawing-offices. Salary £525 per annum, rising by annual increments of £25 to £575 per annum.

Applications should be sent to Professor J. A. L. Matheson, The University, Oxford Road, Manchester, 13. E5937

PETERBOROUGH JOINT EDUCATION BOARD

PETERBOROUGH TECHNICAL COLLEGE

FULL-TIME ASSISTANT TEACHER, GRADE A

Applications are invited for the post of FULL-TIME ASSISTANT TEACHER, Grade A, to teach Mechanical Engineering subjects. Some teaching experience is desirable and salary will be in accordance with the conditions of the Burnham Technical Report.

Suitably qualified applicants may obtain further information and forms of application from the undersigned on receipt of a stamped, addressed foolscap envelope. Application should be made within fourteen days of the appearance of this advertisement.

LESLIE TAIT.
Chief Education Officer.

Education Offices,
Town Hall,
Peterborough. E5970

SURREY EDUCATION COMMITTEE

KINGSTON TECHNICAL COLLEGE, KINGSTON HALL ROAD, KINGSTON-UPON-THAMES

ENGINEERING DEPARTMENT

TECHNICIAN FOR THE ELECTRICAL LABORATORIES

Applications are invited for the post of TECHNICIAN for the Electrical Laboratories of the College. Duties include the construction, maintenance and repair of electrical apparatus. Candidates must have experience in electrical work and have reached the standard of the Ordinary National Certificate in Electrical Engineering. Preference will be given to holders of a Higher National Certificate or its equivalent. Salary scale, £375 by £15 to £420 by £20 to £440, plus London allowance, £30.

Applications, by letter (no form), should be addressed to the Principal as soon as possible. E5968

AIR MINISTRY

CLERK OF WORKS (CONSTRUCTION)

The Royal Air Force invites applications for posts as CLERK OF WORKS (CONSTRUCTION) in the R.A.F. Airfield Construction Trade Group in the ranks of Flight Sergeant and Warrant Officer. Initially, engagements are for five years' Regular and four years' Reserve Service, but all suitable men may re-engage to age 55 and qualify for a substantial pension and terminal grant. Basic weekly pay (exclusive of ration and clothing allowances and increments) is £7 10s. 6d. for a Flight Sergeant (£10 3s. if married), and £8 11s. 6d. for a Warrant Officer (£11 7s. 6d. if married).

Qualifications must include at least 10 years' experience in heavy civil engineering construction with (a) at least five years as general foreman or clerk of works, or (b) at least three years on estimating, costing and management with a contractor, followed by three years as site or general foreman. Preference will be given to candidates who are Associate Members of the Institution of Clerk of Works, but any applicants with comparable experience will be considered, including those with former service in H.M. Forces as clerk of works or equivalent.

Applications, with particulars of training, experience and qualifications, are to be addressed to Inspector of Recruiting, Royal Air Force (C.W.14), Victory House, Kingsway, London, W.C.2. E5925

WARNEFORD GENERAL HOSPITAL

LEAMINGTON SPA

ENGINEER IN CHARGE

ENGINEER IN CHARGE required for the above hospital of 207 beds. Salary commencing at £500 per annum and rising to £600 per annum. Person appointed will be responsible to the Group Engineer for the maintenance of the engineering equipment and building fabric and should hold the ordinary National Certificate in Mechanical Engineering. First-class Board of Trade Certificate or an approved equivalent. Applicants must have served a recognised engineering apprenticeship, had sound experience in the maintenance and operation of steam boiler plant, electrical equipment, heating and hot water supplies, and control of staff. House available for which a rent will be charged. Applications with the names of three referees should be sent to the Group Secretary, 87, Radford Road, Leamington Spa, by 30th November, 1953. E5969

PUBLIC APPOINTMENTS

HER MAJESTY'S COLONIAL SERVICE

PUBLIC WORKS DEPARTMENT (DEVELOPMENT ESTABLISHMENT) NORTHERN RHODESIA (CDE.112/3/04)

MECHANICAL ENGINEER

Duties are to assist the Senior Mechanical Engineer in the administration of Government's Mechanical Workshop Organisation.

Appointment is on contract in the salary scale £940–£1560 per annum—point of entry determined by experience and war service. Cost-of-living allowance varying between £123–£195 10s. per annum. Gratuity of £100–£150 per annum payable on satisfactory completion of contract.

Free passages are provided for the officer, his wife and children up to cost of one adult passage. Partially furnished Government quarters are provided at a rental of 10 per cent. of salary. Leave is granted at the rate of five days for each completed month of resident service after a tour of 36 months.

Candidates, who should be between 28 and 40 years of age, must be A.M.I.Mech.E. or have a Degree in Mechanical Engineering, and should be experienced in the administration of a workshop organisation, and in handling the maintenance of motor vehicles, tractors, and road construction plant. Service in R.E.M.E. advantage.

Apply in writing to the Director of Recruitment (Colonial Service), Colonial Office, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference No. CDE.112/3/04. Closing date for receipt of initial inquiries 2nd December, 1953. E5955

NATIONAL COAL BOARD

PRODUCTION DEPARTMENT

PLANT LAYOUT ENGINEER

National Coal Board invite applications for a post of PLANT LAYOUT ENGINEER in the Engineering Branch of the Production Department in London. This engineer is required to assist in the planning and design of a number of modern workshops which are required in the coalfields for the reconditioning of coal mining and other equipment and plant, and for a small amount of specialised manufacture.

Candidates should be qualified engineers with a comprehensive knowledge of the layout of reconditioning workshops and of the plant, machinery, equipment and services connected with them. They should have had practical and executive experience in the reconditioning of equipment and plant in large quantities and should be fully conversant with the organisation, planning and progressing of modern workshops.

Salary will be in the range of £650–£1250 per annum, according to qualifications and experience. The post is superannuable.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/701. Original testimonials should not be forwarded. Closing date 27th November, 1953. E5935

MINISTRY OF WORKS

STRUCTURAL ENGINEERING DRAUGHTSMEN

STRUCTURAL ENGINEERING DRAUGHTSMEN required in London, at Risley (Warrington), Harwell (near Didcot, Berks.), Reading and Cambridge.

Accommodation available for single men at Risley and Harwell.

London salary: Up to £628 per annum. Starting pay according to age, qualifications and experience. Rates outside London slightly lower.

Applicants should be experienced in design and/or detailing of either reinforced concrete or structural steelwork. The work is varied and not confined to standard schemes.

Reasonable prospects of promotion. Although not established posts, many have long-term possibilities. Competitions are held periodically to fill established vacancies.

Write, stating age, nationality, experience and locality preferred, to Chief Structural Engineer, W.G.10/S.3 (K), Ministry of Works, Abell House, John Islip Street, London S.W.1. E5631

CITY AND COUNTY OF KINGSTON UPON HULL

WATER DEPARTMENT

APPOINTMENT OF TECHNICAL STAFF

Applications are invited for the appointment of an ENGINEERING ASSISTANT at the maximum salary (viz., £735 per annum) of Grade VI, A.P.T. Division of the National Joint Council's Scales.

Applicants must be Corporate Members of the Institution of Mechanical Engineers and must have had considerable experience in the design and maintenance of large pumping plants.

The appointment will be subject to one month's notice on either side, to the National Scheme of Conditions of Service, to the Local Government Superannuation Act, 1937, and to the passing of a medical examination.

Housing accommodation may be provided for the successful candidate.

Applications, giving age, details of education, qualifications and experience, and accompanied by copies of two recent testimonials, must reach the undersigned not later than the 21st November, 1953.

T. H. JONES, M.I.C.E., M.I.W.E.,
Water Engineer and Manager.

Water Department,
Alfred Gelder Street,
Kingston upon Hull. E5913

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS, PATENT EXAMINER AND PATENT OFFICER CLASSES

The Civil Service Commissioners invite applications for permanent and pensionable appointments to be filled by frequent competitive interviews. The scientific posts are in various Government Departments and cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small; individual vacancies exist at present for candidates who have specialised in palaeobotany, invertebrate fossils, and foraminifera. The patent posts are in the Patent Office (Board of Trade), Admiralty and Ministry of Supply.

Candidates must have obtained a University Degree with first or second-class honours in an appropriate scientific subject (including engineering) or in mathematics, or an equivalent qualification; or for scientific posts possess high professional attainments. Candidates for Senior Scientific Officer posts must, in addition, have had at least three years' post-graduate or other approved experience.

Age limits: Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For Scientific Officers and Patent Classes, between 21 and 28 during 1953 (up to 31 for permanent members of the Experimental Officer Class competing as Scientific Officers). Inclusive London salary scales: Senior Scientific Officers (men) £917-£1075, (women) £681-£917; Scientific Officers (men) £440-£812, (women) £440-£576; Patent Examiner and Patent Officer Classes (men) £440-£760, (women) £440-£576. Women's rates under review. Somewhat lower rates in the provinces.

Further particulars from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.53/53 for Senior Scientific Officers and S.52/53, S.128/53 for the other posts. Completed application forms to be returned on or before 31st December, 1953. E5938

HER MAJESTY'S COLONIAL SERVICE

PUBLIC WORKS DEPARTMENT, KENYA

HYDRAULIC ENGINEERS

Applications are invited for the following posts:—HYDRAULIC ENGINEERS, Public Works Department, Kenya.

Duties include investigation, design, construction, and maintenance of township water supplies, development of rural water supplies and water conservation.

Candidates, who should not be over 30, must hold a University Degree or Diploma in Civil Engineering carrying exemption from Sections I and II of the Institution of Civil Engineers' examinations or be A.M.I.C.E., and should have had three years' general hydraulic experience or water supply, &c.

Appointment is on contract; basic salary in scale £830–£1410 p.a. plus variable cost-of-living allowance (maximum £350 p.a.). Substantial gratuity payable on completion of contract.

Full details on application.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number CDE 112/7/02. E5942

LONDON ELECTRICITY BOARD

CHIEF ENGINEER'S DEPARTMENT

Applications are invited for the following positions in Central London.

STRUCTURAL ASSISTANTS and STRUCTURAL DRAUGHTSMEN (Construction Branch). Applicants for positions of Structural Assistants should have experience in the design and detailing of reinforced concrete heavy foundations, framed superstructures, and other structural works. Applicants for Structural Draughtsmen should have experience in detailing reinforced concrete structures.

The posts are graded under Schedule "D," National Joint Board agreement as Grade 5—£595 7s. to £704 11s. and Grade 6—£458 to £595 7s. per annum, respectively, inclusive of London Allowance. Commencing salaries will be dependent upon qualifications and experience.

ARCHITECTURAL DRAUGHTSMAN

Applicants should be neat draughtsmen and preferably have had several years' experience in an architect's office.

The post is graded under Schedule "D" of the National Joint Board agreement as Grade 6—£458 to £595 7s. per annum, inclusive of London Allowance.

Application forms obtainable from Establishments Officer, 46, New Broad Street, E.C.2, to be returned completed by 21st November, 1953. Please enclose addressed foolscap envelope and quote Ref. V/1683/EE on all correspondence. E5873

HOSPITAL MANAGEMENT COMMITTEE HACKNEY GROUP

APPOINTMENT OF ASSISTANT ENGINEER

Applications are invited for the above APPOINTMENT (£425 by £15 to £500, plus London weighting), preference being given to candidates possessing an Ordinary National Certificate in Mechanical Engineering or holding an equivalent qualification. Whitley Council service conditions. The successful candidate will serve in the first instance at the Eastern Hospital, Homerton, E.9.—Applications in writing to Group Secretary, Hackney Hospital, London, E.9, by 16th November. E5920

PUBLIC APPOINTMENTS

AIR MINISTRY

CLERK OF WORKS (ARTISAN)

The Royal Air Force invites applications for po... as CLERK OF WORKS (ARTISAN) in the R.A... Airfield Construction Trade Group in the rank... Flight Sergeant and Warrant Officer. Initia... engagements are for five years' Regular and fo... years' Reserve Service, but all suitable men m... re-engage to age 55 and qualify for a substan... pension and terminal grant. Basic weekly p... (exclusive of ration and clothing allowances ... increments) is £7 10s. 6d. for a Flight Serge... (£10 3s. if married), and £8 11s. 6d. for a Warra... Officer (£11 7s. 6d. if married).

Qualifications required are (a) an apprenticesh... as a craftsman with three years as foreman of tr... and three years as general foreman or clerk of wor... or (b) three years' full-time, five years' evening, tra... ing in a building school instead of normal apprenti... ship, or (c) at least three years' experience in ... builder's general office on costing, estimating a... management, followed by three years as site ... general foreman. Preference will be given to ap... cants with the Ordinary National Certificate ... Building, or Intermediate City and Guilds Certific... in a craft, or Associate Membership of the Institu... of Clerks of Works, or First-Class Certificate ... Worshipful Company of Carpenters or equivale... but any applicants with comparable experience w... be considered, including those with former ser... in H.M. Forces as Clerk of Works or equivalent.

Applications, with particulars of training, expe... ence and qualifications, are to be addressed to t... Inspector of Recruiting, Royal Air Force (C.W.1... Victory House, Kingsway, London, W.C.2. E5920

CITY OF BIRMINGHAM

PUBLIC HEALTH DEPARTMENT

SMOKE AND FACTORIES INSPECTORS

Applications are invited for the above posts fr... candidates possessing the Board of Trade (Steam... Engineering Certificate or its equivalent. Applic... tions from qualified Sanitary Inspectors hold... the Royal Sanitary Institute Smoke Inspector... Certificate will also be considered.

The duties include the abatement of atmospher... pollution and noise, inspection of factories and wor... places and the duties as an authorised officer und... the Heating Appliances (Fire Guards) Act, 1952.

Salary within A.P.T. Grades I to V (£465–£6... per annum), according to qualifications and exper... ence; pension scheme, including widows a... orphans; medical examination.

Applications, stating age, qualifications, presen... salary, length of service and experience, togeth... with the names of two referees, should be sent ... the Medical Officer of Health, Public Health Depar... ment, Congreve Street, Birmingham, 3, not la... than 21st November, 1953. E5879

ADMIRALTY

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICER AND SCIENTIFIC OFFICER

Applications are invited for appointments ... SENIOR SCIENTIFIC OFFICER and SCIENTIFI... OFFICER Grades in Experimental Establishments ... London, Portsmouth, Weymouth and Gloucest... shire areas and Scotland. The majority of posts a... for Engineers and Physicists (particularly wi... Electronics), but there are a few posts for Physici... Chemists and Metallurgists. Candidates must b... British subjects with an appropriate First or Second... Class Honours Degree or equivalent high professiona... attainments. London salary inclusive of pay additi... (men) S.S.O.s, £917–£1075, S.O.s, £440–£812. A... appointments are unestablished (with F.S.S.U.), bu... with some opportunities to compete for establishe... posts.—Application forms from M.L.N.S., Technica... and Scientific Register (K), 26, King Street, London... S.W.1, quoting A 246/52/A/BH. E5861

QUANTITY SURVEYOR

TAKORADI HARBOUR EXTENSIONS GOLD COAST

QUANTITY SURVEYOR required for Takora... Harbour Extensions, Gold Coast Local Civil Servi... for one tour of twelve months. Salary, &c., up t... £2020 a year; free passages. Candidates must b... fully qualified quantity surveyors with experience i... measuring and costing harbour works.

Write to the Crown Agents, 4, Millbank, London, ... S.W.1. State age, name in block letters, full quali... fications and experience, and quote M2B/30146/EH. E5954

THE PRODUCTION ENGINEERING RESEARCH ASSOCIATION

ASSISTANT PHOTOGRAPHER

The Production Engineering Research Association ... requires an ASSISTANT PHOTOGRAPHER for ... an interesting, progressive position.—Applicants ... should send details of experience, qualifications, age ... and salary required, to the Secretary, Staveley Lodge, ... Melton Mowbray, Leicestershire. E5903

PEPPARD CHEST HOSPITAL

HENLEY-ON-THAMES (244 BEDS)

ASSISTANT ENGINEER

ASSISTANT ENGINEER required. Salary £42... by £15 to £500 per annum.—Forms of application ... from the Group Secretary, 3, Craven Road, Reading, ... Berks. E5945

THE ENGINEER

NOVEMBER 6, 1953

British Standards Institution

THE British Standards Institution is now settled in its new home at 2, Park Street, London, W.1, and on three evenings last week members of the Institution and representatives of industry and the press were invited to inspect the premises. The new building, which is arranged in eight storeys, was designed originally for luxury residential purposes, and has been converted to meet the extensive requirements of the B.S.I. under the direction of Mr. Rowland Pierce. The library and the sales branch are accommodated on the ground floor and, as there are now over 2000 current British standards, the stock that is maintained in the sales branch and in adjacent storage amounts to about 1,500,000 copies. The first, second and fourth floors house the administrative departments and the directorate, and include council and committee rooms, and the third floor is occupied wholly by the technical staffs engaged on mechanical and electrical engineering standards. The drawing-office and editorial department, together with the technical staffs of the building and chemical sections, are on the fifth floor, and on the sixth floor are the metallurgy section, the staff concerned with overseas and miscellaneous engineering standardisation, the Canadian "approvals" section, and the finance department. On the seventh floor there is housed the administrative staff of the certification trade marks section. The annual general meeting of the Institution was held on Thursday of last week, when Sir Roger Duncalfe was elected president in succession to Viscount Waverley, P.C., F.R.S., who has now completed his three-year term of office. Sir Roger, who is chairman of British Glues and Chemicals, Ltd., has been closely associated with the work of the B.S.I. for over twenty years. His knighthood was conferred at the time of the Institution's golden jubilee in 1951 for his outstanding contribution to industrial standardisation.

North of Scotland Hydro-Electric Board

MR. T. LAWRIE, general manager of the North of Scotland Hydro-Electric Board, delivered an address in Dundee, on Tuesday, October 27th, in which he commented on the progress made by the board since it was formed by Act of Parliament ten years ago ; he also gave his ideas of the next ten years' work. The affairs of the board, particularly its technical and constructional interests, have always been fairly comprehensively recorded in THE ENGINEER, and we think that much of Mr. Laurie's account will be familiar to our readers. The general picture of ten years' work is not, however, without interest. Mr. Lawrie grouped the principal duties of the board in three categories, namely, to develop hydro-electric power, to distribute electricity, and to collaborate in measures for the economic development of its supply area. Construction had been going on for about seven or eight years, he noted, and the first schemes went into service four years ago. Seventeen hydro-electric power stations, totalling 398MW, had been completed, and twenty-four, totalling 465MW, were under construction. He mentioned various aspects of dam and tunnel construction, including the board's adoption of the Trief process at two dams of the Moriston scheme ; at the present time, he said, tunnels were being driven at a rate of about a mile a month. Mr. Lawrie asserted that the styles of the board's power stations had not been stereotyped ; he was glad to say that the board had made progress in construction with native stone. Such construction cost more, he said, but gave better appearance, lower maintenance, and a longer life, whilst more of the cost was spent locally. When the responsibility for distributing electricity throughout the whole of the North of Scotland was placed on the board 5½ years ago, Mr. Lawrie noted, 180,000 consumers, mainly in country districts, were without supplies. More than half of them had since been connected, he said, but less than half of the work had been done, because those who had not yet received a supply lived in the remoter places.

Safety in Mines Research

THE Ministry of Fuel and Power has issued the thirty-first annual report of its Safety in Mines Research Establishment. It deals with the work accomplished during 1952, in which year the Safety in Mines Research Board met three times. At one of these meetings, the report states, the Board discussed progress in methane drainage and the development of hydraulic chocks. There was also discussion on the ignition of firedamp by frictional sparks, which have been responsible for approximately the same number of ignitions as explosives. It was recommended by the Board that basic research on the ignition of firedamp by friction should be undertaken immediately and that a committee, including mining engineers, should consider steps for reducing the hazard underground. The report contains a survey of the work done last year on explosion and fire hazards, dust control and the pneumoconiosis hazard, and it also records the activities of the Establishment's testing services and the engineering and metallurgical research units. In this last-mentioned section of the report, some description is given of the methods of non-destructive testing of haulage winding and other gear. The report says that the testing equipment employed included a magnetic crack detector, an ultrasonic flaw detector, a specimen of radio-active iridium 192 in a container or "bomb" providing a 500 millicurie source of gamma rays, films for making radiographs, and an assortment of accessories necessary for testing a variety of gear. The apparatus, carried in a light 10-cwt van, required only a mains supply of electricity for its operation. An appendix to the report gives a list of the papers presented to the seventh International Conference of Directors of Safety in Mines Research, which was held at Buxton in July, 1952.

Industrial Research in Wales

THE Department of Scientific and Industrial Research has appointed Dr. R. O. Jones to be its first resident liaison officer in Wales. His task will be to study the industrial position in Wales with a view to assisting in the identification of industrial problems amenable to research and in the application of existing knowledge and research facilities to meet Welsh needs. Dr. Jones will work in collaboration with other Government departments in Wales and with Welsh industrial and regional organisations. It is hoped by this means to provide a link between Welsh firms and the research laboratories of the D.S.I.R., the research associations, and others, and to make more readily accessible in Wales the scientific information already available within the D.S.I.R. organisation. Dr. Jones has already spent over a year in a preliminary examination of Welsh industrial research problems. In recent years he has served on the headquarters staff of the D.S.I.R., prior to which he was concerned with the development and utilisation of non-ferrous minerals, after having served for some time with the Geological Survey and Museum. He is a member of the Court of the University of Wales, of the Court of Governors of the University College of South Wales and Monmouthshire, and of various educational and other bodies associated with the Principality. Dr. Jones's office is situated in the building occupied by the Welsh Board of Health, Cathays Park, Cardiff (telephone, Cardiff 5120).

Report on Collision on the Central Line

THE report has now been issued by the Ministry of Transport of the inquiry into the collision which occurred on the evening of Wednesday, April 8th last, near Stratford, on the Central Line of London Transport. This accident was the first to occur in which passengers were killed since the tube railways were opened some sixty years ago. In this accident an eastbound train running under the "stop and proceed" rule, collided at a speed of about 20 miles an hour with the rear of a similar preceding train which was stationary in the tube tunnel between Stratford and Leyton. As a result of the collision twelve passengers lost their lives, four passengers and the driver of the train were seriously injured, and forty-one passengers were slightly injured or suffered from shock. The "stop and proceed" rule was in operation at the time owing to a signal defect at Stratford, and train drivers were being instructed to pass their signal at danger. As a result of his inquiry into the accident the inspecting officer, Colonel D. McMullen, concluded that the driver of the train which ran into the rear of the stationary train failed to comply with the "stop and proceed" rule, in that he did not exercise even reasonable caution. He allowed his train to coast with little, if any, brake power applied, almost up to the point of the impact, by which time the speed had reached about 20 miles an hour. Having regard to the gradient and curvature of the line such a speed was very much too high and should not have exceeded 5 miles an hour. Colonel McMullen was satisfied that there was no defect on the train involved and that the signalling arrangements were in good order.

Exchange of Students for Technical Experience

THE International Association for the Exchange of Students for Technical Experience has just published its sixth annual report. It records the continuing progress of a work which was started in 1948. During the summer of 1953, no less than 3783 students from eighteen countries took part in the exchanges in order to add to their technical experience. They included 312 students in chemical engineering ; 413 in civil engineering ; 600 in electrical engineering ; 958 in mechanical engineering; 155 in metallurgy; 75 in marine engineering and shipbuilding ; eight in oil technology, and one in gas engineering, the remainder being concerned with studies outside the engineering field. The report records appreciation of the co-operation given to the scheme by industrial and commercial undertakings in the participating countries, although it says that in some member countries "the administration of the exchange still leaves much to be desired." The Association's constant endeavour is to promote and maintain a high standard of efficiency, and its rules now require that secretaries in member countries shall be permanent and not change from year to year. The report adds that in many of the member countries the Association's national committees are receiving the support of their respective Governments, a step which is helping considerably in the covering of a bigger field of activity. The general secretary of the Association is Mr. J. Newby, Imperial College of Science and Technology, South Kensington, London, S.W.7.

Hydro-Electric Development in Portugal

RIVER ZEZERE SCHEME: CASTELO DO BODE POWER STATION

No. II—(*Continued from page 549, October 30th*)

The generating stations at Castelo do Bode on the River Zezere and at Vila Nova on the River Cavado are among the more important hydro-electric developments recently started in Portugal. The Castelo do Bode station is equipped with three generating sets with a total output rating of 172·2MVA, and a description of the plant and equipment is given here.

Hydro-Electric Plant

Turbines.—The three main turbines are vertical shaft reaction machines, designed to give an output of 73,000 h.p. under a maximum net head of 95m (317ft), and 62,000 h.p. under an average net head of 80m (262ft). The discharges under these conditions are 65·8 cubic metres (2323 cubic feet) per second and 66·3 cubic metres (2340 cubic feet) per second, respectively. The headwater level under normal conditions of operation varies between 79m (259ft) and 122m (400ft) and the tailwater level between 23·50m (77ft) and 25m (82ft). Under exceptional flood conditions the tailwater can attain a height of 32·50m (107ft).

The normal speed of the turbines is 214 r.p.m. and their runaway speed under maximum head will not exceed 400 r.p.m. The resulting specific speed of the runner, which is quite high for the operating head, is made possible by accurate design and streamline finish of the runner vanes and the sufficiently low setting of the turbines.

In the construction of the turbines much use has been made of welding. The spiral casing (Fig. 8), which has an inlet diameter of 3·35m (11ft) is built up of electrically-welded mild steel plates graduated in thickness from 32mm (1¼in) to 19mm (¾in) to suit the load, with butt joints between plate segments. The speed ring bridging the throat of the spiral casing is also electrically-welded. It consists of two guide rings to form the throat and a series of streamlined stay vanes for bridging the throat, transmitting the weight of the whole unit to the foundations and guiding the water to the gate apparatus. To facilitate transport the spiral/speed ring assembly was delivered in four complete sections, the plates of each part being welded to each other and to the speed ring quadrants in the works. At site, the sections were joined together by bolts for the speed ring and by welding for the spiral, and the finished casing was then pressure-tested to 17 atmospheres, which is 1·75 times the maximum static head. For this purpose a test cylinder was supplied for closing the throat of the casing and a test flange for closing the inlet. The spiral casing was then drowned in the foundation concrete.

The speed ring, which bridges the throat gap of the spiral casing and transmits the weight of the whole unit to the foundations, is made of cast steel in sections and has two guide rings, an upper ring to carry the generator support and turbine cover and a lower ring to carry the pivot ring. The two rings are tied together by streamlined stay vanes which guide the water to the gate apparatus.

The turbine cover which is bolted to the speed ring is fabricated of mild steel and is of box construction. It carries the swivel gate stem bearings, gunmetal bushed, and the main shaft gland. An interesting point is the sealing of this gland by sectionalised carbon rings flexibly mounted on springs and held against a steel ring on the shaft by garter springs.

The runner is made of cast steel and the vanes are protected at the outlet by stainless steel welded on the surface and then ground and polished. Labyrinth seals are provided on the runner crown and rim to reduce gap losses. The overall diameter of the wheel is 3·28m (10ft 9in).

Resting on the turbine speed ring is the generator supporting barrel, which is a strong fabricated steel structure that connects the generator and turbine and transmits the generator load to the foundations. It is buried in reinforced concrete and forms the generator plinth. One of the generator support and spiral casing assemblies is shown in Fig. 9.

The draught tube is specially designed to allow removal of the runner from below. It comprises a removable throat section at the top, fitting inside the foundation ring of the turbine. Below is a cone in sections, surrounded by a gallery and having a wedge-shaped dismantling joint at the bottom. Lower still is the foundation ring of the draught tube and the steel lining of the draught tube bend, both drowned in the concrete of the foundations. To lower the runner the cone in sections is first removed along the

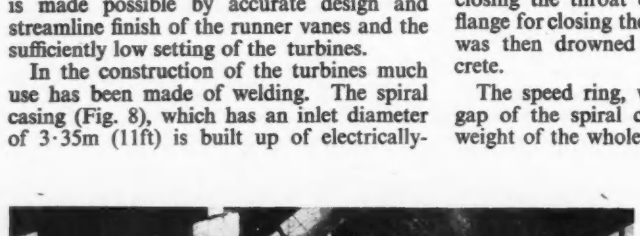

Fig. 8—73,000 H.P. Turbine Spiral Casing at Works

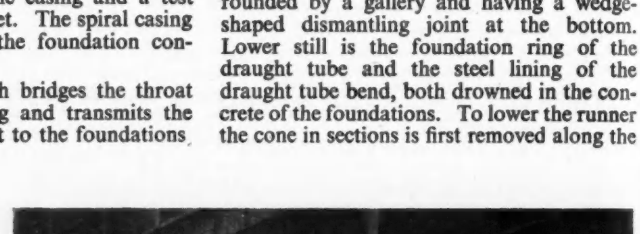

Fig. 9—Turbine Spiral Casing and Generator Support Assembly at Works

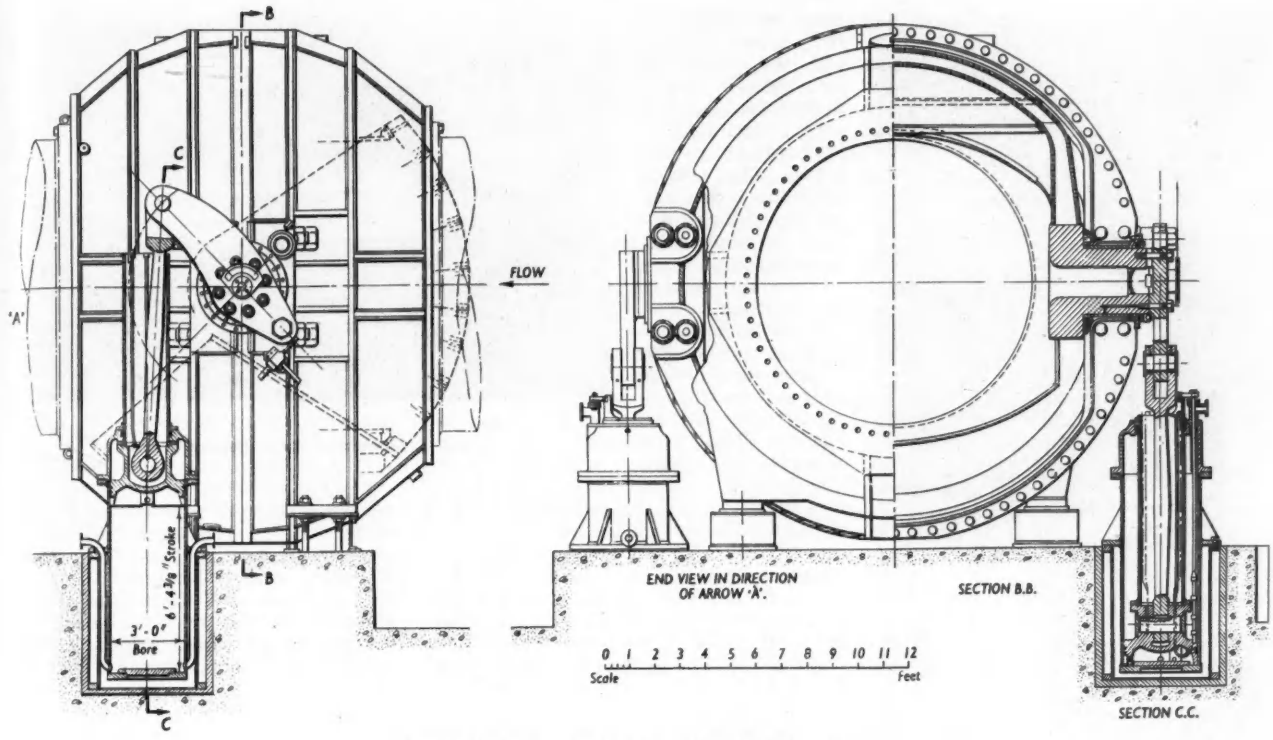

Fig. 10—Arrangement of 11ft Bore "Straight Flow" Valve

dismantling gallery. The cap nut on the runner cover is removed and a cable attached to the main crane hook passed down the bore of the main shaft of the unit, whereupon the crane can be used for all the dismantling operations. Next, the draught tube throat is lowered on to a bogie (rails having been laid across the draught tube foundation ring) and taken away. Then the runner cover is removed and the runner is lowered on to the bogie. The bogie is then pulled along the dismantling gallery and the runner can be hoisted to a higher level.

The lubricating system for the turbine bearing is separate from that for the generator bearings. There are two pumps (one being a standby), each capable of supplying all the oil required. They are rated at 3 h.p. at 1450 r.p.m. The main pump is driven by an a.c. motor and the standby by a d.c. motor fed from the station battery. If, for any reason, the oil supply from the a.c. motor fails, the d.c. motor is started automatically by means of a relay and an alarm is sounded.

In order to prevent excessive suction on sudden drop in load and to secure smooth operation at part-gate opening, air snifting equipment is provided for admitting air to the underside of the runner. The air is admitted by the action of an automatic valve operated from the governor and is conveyed to the centre of the draught tube through radial arms and a streamlined hub.

Turbine Governing System.—The governing system is automatic and oil-pressure operated. The governor actuator pendulum is driven by an electric motor which is supplied by a special alternator mounted on the main generator shaft ; it is thus operated on the synchronous electric principle. The pendulum operates a distributing valve which (by way of a pilot servomotor), controls the pressure oil to the two oil servomotors. By means of steel rods, these servomotors operate the regulating ring which opens and closes the turbine gates. The servomotors receive their pressure oil from an oil pumping unit which consists of a screw pump driven by a squirrel-cage motor of 35 h.p. at 1450 r.p.m. Beside the pumping set is an oil pressure receiver which acts as a pressure reservoir and maintains the correct oil pressure. Air is supplied to the receiver from the station compressor. Cooling of the oil is effected by water circulating through a coil inside the oil sump.

Each turbine is provided with an emergency overspeed governing device to operate when the speed exceeds the normal by 33 per cent. A spring-loaded centrifugal pendulum is mounted on the main shaft and it closes both the turbine gates and the main inlet valves by means of a tripping gear.

"Straight-Flow" Inlet Valves.—The main inlet valves (Fig. 10) are of the "Straight-Flow" design, 3·35m (11ft) bore, and are operated by two external servomotors actuated by water pressure. The valve consists of a main body and a door, hemispherical in form, both of fabricated construction.

The door has two sections, one solid and the other pierced so as to fill the gap in the main body and so continue the smooth bore of the main body and the pipeline when the valve is open. The solid section closes the pipe bore and has a rustless seating for a rubber sealing device which forms a watertight joint when forced against the seating by pipeline water pressure. The valve is fitted with an isolating device to permit of inspection and to enable the main water seal to be replaced if necessary without emptying the pipeline or breaking the flange joints. The valve can be operated either by remote electrical control from the turbine gauge panel or locally from the valve control panel. In Fig. 11 we show a valve being lowered into position at site. These valves are believed to be the largest smooth bore rotary valves in the world.

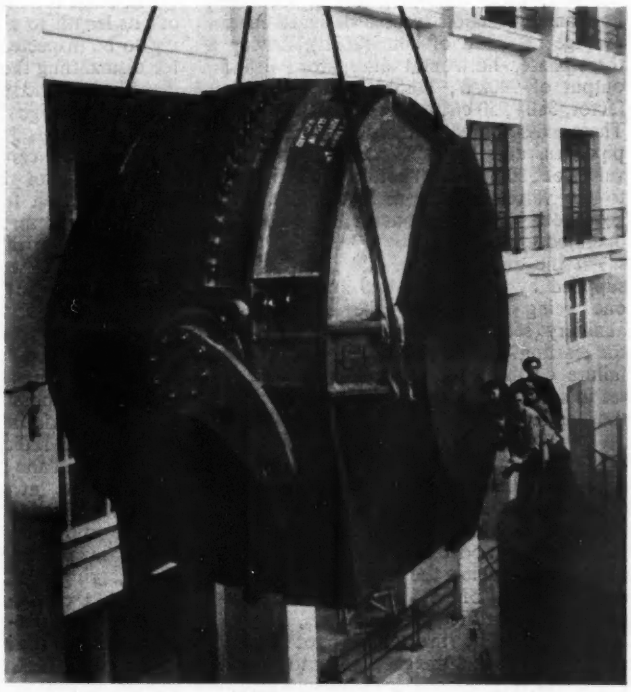

Fig. 11—"Straight Flow" Valve Being Installed

Auxiliary Generating Sets.—Underneath the loading bay and at the same level as the main machine hall are two auxiliary generat-

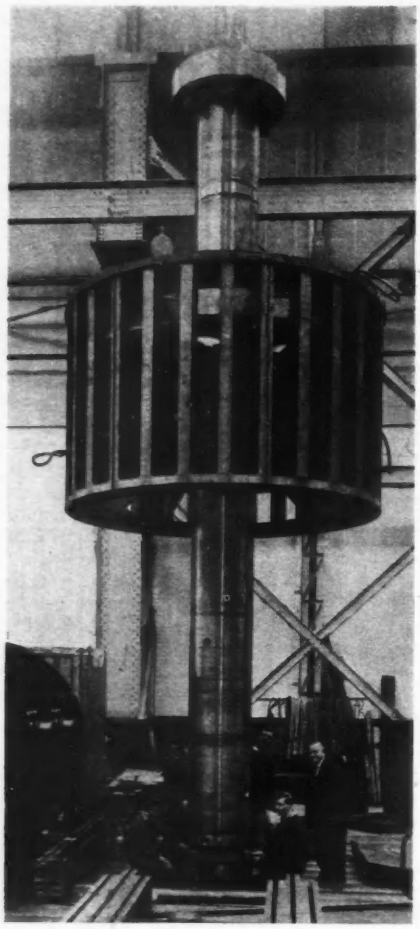

Fig. 12—57·4MVA Generator Rotor Hub and Shaft

ing sets, each consisting of a 1300 h.p. horizontal, reaction turbine designed for an average net head of 80m (262ft), driving a three-phase, horizontal alternator with an output of 900kW, 1185kVA at 0·8 power factor, 380V, 50 c/s, at a speed of 1000 r.p.m. These units are fed by their own independent pipelines, and have "Straight Flow" inlet valves of 560mm (22in) bore, similar in design to the valves for the main turbines. The governors are automatic, oil-pressure operated.

All the auxiliaries for the main sets are supplied by one of the two auxiliary units, one being standby to the other. Both auxiliary sets are automatically controlled for starting up and shutting down, and, on failure of the low-tension supply from the set in service, it is automatically replaced by the standby set.

Main Generators

The generators are vertical shaft, enclosed, self-ventilated machines, and are arranged with two bearings, a combined thrust and guide bearing above the rotor, and a second guide bearing below the rotor. The machines are rated at 45MW, 57·4MVA at 0·786 power factor, three-phase, 50 c/s, 15·5kV, 214 r.p.m. The main and pilot exciters and the permanent-magnet governor generator are directly coupled to the main generator and are mounted above the rotor.

The stator frame is of welded steel and is divided into four sections for ease of shipment, each quarter section, weighing about 30 tons, being dispatched complete with core and windings. The four sections were bolted together at site, and the connections completed across the joints. The top of the frame has facings for the upper bracket and the bottom is arranged for bolting direct to special facings on the steel supporting barrel already described. The core is built up of thin laminations of high-grade iron, the whole being maintained in tight compression between the endplates.

The stator has a two-layer basket winding in open slots, and all coils are interchangeable. The insulation is Class B. The coils are retained by slot wedges and the end windings are braced against movement under short circuit conditions. Six temperature detectors are embedded in the windings where the highest temperature is to be expected, and the leads from the elements are taken to a temperature indicating instrument. The poles are made of laminated steel and are fitted into slots on the rotor rim and secured by taper keys. The field coils are formed of copper strip wound on edge and damping windings are fitted in the rotor poles. The rotor body consists of a central hub keyed to the shaft and an outer rim, into which the poles are fitted. This rim is built up of laminations of high-grade ductile steel and the segments of the laminations are overlapped and secured between thick endplates. This results in a complete ring of adequate strength to withstand the stresses which occur at maximum runaway speed. Furthermore, the rim is free to expand under centrifugal force without transmitting any load due to the centrifugal effect on the hub.

The shaft is a steel forging bored throughout its length to allow the centre of the forging to be inspected, and to provide facilities for dismantling the turbine runner as already described. The complete generator rotor with shaft weighs about 240 tons and the flywheel effect is $3 \cdot 20 \times 10^6$ lb-ft^2. The rotor hub and shaft can be seen in Fig. 12. The whole weight of the rotating parts plus the hydraulic thrust from the turbine is carried by a tilted-pad thrust bearing (Fig. 13). The bearing surface of a rotating thrust collar, mounted on the upper end of the generator shaft, rests on the "babbitted" surfaces of a number of thrust pads. Each pad is supported by a steel disc which is pivoted on a dome-shaped hardened steel insert fitted in the top of an adjusting screw. Thus, individual adjustment is possible for each pad, and each pad is free to tilt in any direction, but circumferential and radial movement is prevented by a dowel at the inner circumference and a locking plate at the outer circumference. The pad-adjusting screws are carried by a massive support ring, and, when set, are locked in position by grub screws. The support ring rests on an equaliser which provides a cushioning effect to compensate for any slight out-of-truth of the thrust face relative to the shaft axis. The equaliser rests solidly on the base of the thrust pot. A guide bearing is contained in the same thrust pot and this also consists of individually adjustable pads which bear on the vertical face on the thrust collar.

A pumped oil lubricating system is used, oil being pumped from the sump via an oil cooler to the annulus between the inner sleeve of the thrust pot and the thrust pads at the level of the bearing surface. Oil is

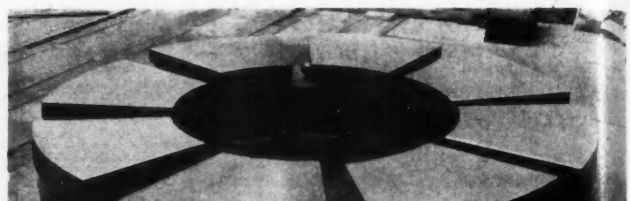

Fig. 13—Generator Thrust Bearing Assembly

also fed to this point by natural circulation within the pot. The centrifugal pumping action of the rotating thrust face forces the oil radially outwards between the thrust pads, the correct oil level within the pot being maintained by two weirs over which the oil spills into pockets, from which it flows back to the sump. Thermometers are fitted in the bearing pads and in the oil feed to the thrust pot to sound an alarm should any abnormal condition arise. Additional thermometers in the thrust pads shut the set down at a higher temperature setting. The upper and lower guide bearings are also included in the same lubricating system which, like the turbine system, provides for an a.c. motor-

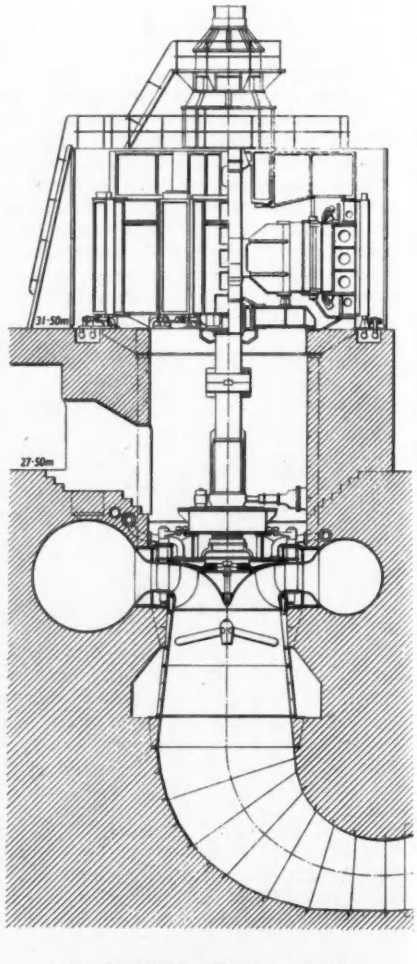

Fig. 14—73,000 H.P. Water Turbine and Generator

driven pump with a d.c. motor-driven pump as standby. The latter is started up automatically if the oil flow falls below a predetermined value.

A set of air-operated brakes is provided to bring the rotor to rest quickly when the set is shut down and thus avoid damage to the thrust bearing. An air compressor equipment of sufficient capacity to serve two generators is provided. The brakes are also designed to act as jacks for lifting the rotor during erection, and for this purpose high-pressure oil from an oil pump is used.

A closed circuit system of ventilation has been adopted, the air being circulated by fans on the rotor. Eight water-cooled air coolers are mounted in the annular space between the stator frame and the outer casing and the water for these coolers is supplied from the pipeline through filters.

A complete fire quenching equipment is provided to serve two generators. Carbon dioxide gas is automatically injected into the closed ventilation system on the operation of circulating current protection or an emergency push-button switch. The voltage of 165kV at the secondary terminals of the transformers is kept constant over the full voltage range from no load to full load by adjusting the generator voltage by means of an automatic voltage regulator.

The sets are designed to run as synchronous condensers having an output of 40MVA at zero power factor (over-excited). For this purpose, the water level of the turbine draught tube has to be kept below the runner level at all tailrace levels and this is achieved by admitting to the draught tube compressed air from the large air receiver and special compressor already mentioned. The general design of the combined unit, both turbine and generator, can be seen in Fig. 14.

Transformers. — The main transformers which, as already mentioned, are installed on a platform downstream of the machine hall, are three-phase units rated at 52·5MVA, with a voltage ratio of 15·8kV/165kV at full load, and 0·85 power factor. The lower voltage windings are delta connected and the high voltage side is star connected with the neutral point solidly earthed. The 165kV windings have ±5 per cent tappings connected to an externally-operated off-circuit tapping switch. The transformer losses are dissipated by forced oil circulation through water-cooled coolers. Each transformer weighs 120 tons (83 tons stripped for transport).

(To be continued)

Military and Civilian Rocket Research

By ERIC BURGESS, F.R.A.S.

Nearly all research into high-altitude rockets and much other rocket research is being carried out for military purposes. In its relation to the setting up of an artificial earth satellite the author regards this concentration of research upon military purposes as unfortunate and even dangerous. He calls for the setting up of an international body to take up work leading towards the creation of an artificial satellite—a body that would publish openly all results of its work.

BECAUSE of its necessity in the guided missile programme much attention has been given to rocketry in the last ten years. Throughout the world teams of scientists and engineers have produced reliable and efficient rocket motors for the propulsion of winged and projectile type missiles, for aircraft power plants and assisted take-off and for high-altitude research. A large number of propellant combinations have been tested and evaluated. Basically, however, there appear to have been no really new developments, nor can we really expect any. Engineers have now almost exhausted the store of basic knowledge by catching up on the scientists. In a recent paper[1] von Braun admitted that the development of the German "A–4" rocket was contingent upon research data and accumulated scientific knowledge obtained over a period of the previous twenty years. Moreover, he emphasised that at present the harvest of knowledge has been virtually exhausted so that rapid progress in advanced rocketry is blocked by the absence of new perceptions in the field of basic research.

A direct result of this situation is that progress during recent years has been comparatively slow. More results of basic work are needed concerning propellants, high-temperature nozzles and ceramics, rocket motor cooling and the protection of the outer skins for high-speed rocket-propelled craft. In view of such difficulties it is very unlikely that space ships, about which so much has been written, technically as well as imaginatively, will be developed for a considerable time yet. Manned flight between the planets of the solar system cannot, therefore, be regarded as a possibility of the immediate future and if plans for such flights are made on the basis of man's present limited knowledge they lead to some interplanetary dreamland.

But, nevertheless, present-day knowledge is believed to be sufficiently advanced to allow a start to be made towards achieving space flight. Modern high-altitude rockets can be regarded as increasingly becoming prototypes for future space vessels.[2, 3] Their operation and design and the experience gained therefrom must lead ultimately to larger rockets which can begin to probe into space. This type of work with high-altitude sounding rockets is of particular importance for it is establishing the necessary techniques of operating large rockets, simplifying launching procedure and control, developing radio telemetering, radar and optical tracking, instrumentation and, most important, assuring the co-ordination of the work of engineers and scientists. All these techniques will have to be perfected before man can really aspire towards interplanetary flight.

The largest rocket so far constructed still remains the "A–4" (12 tons), although there is now much engineering experience in building fairly large rockets such as the "Viking" (5 tons). The step rocket principle has been tested and practical difficulties of programming the step separation have been overcome. Project "Hermes" of the General Electric Company gave experience in the assembly and firing of nine "Bumper Wacs" (two-step combinations of "A–4" and American "Wac Corporal").[4] Control of flight is also progressing because this is an urgent problem in the guided missile industry. Many new electronic devices are being used in this connection. These results which are now being obtained for missile guidance are of special importance to space flight, for accurate control is essential if orbits are to be followed as scheduled. Cut-off velocity and direction of the rocket at all-burnt must be controlled with precision. For it appears that errors of a few centimetres per second in cut-off velocity can put the interplanetary missile many hundreds of kilometres out of course.[5]

The best chemical propellant combinations can nowadays give a specific impulse in the region of 250 sec. Rockets having a structural factor of 0·2 (where structural factor is defined as the ratio of structure weight of the rocket, excluding payload, to the structure weight plus propellant weight) can be built. Although there are possibilities of other high-performance rocket propellants, which may give 300 sec to 350 sec specific impulse, becoming practicable, handling difficulties at present limit their use. There are also possibilities of improving the structural factor. Nevertheless, modern propellants and present-day methods of rocket construction are claimed to be sufficient to allow the establishment of an instrumented earth satellite vehicle,[6] of modest proportions.

Unfortunately, all modern rocket research is concerned with military objectives, for the reason that the enormous funds needed for such work can be found only for military purposes. Even the high-altitude research programme began as an offshoot from the firing of captured German "A–4" rockets to give military personnel experience in their handling. The greater proportion of the work being done has a military usefulness and, therefore, comes under the security blanket. Even such seemingly innocuous studies as those concerned with sky brightness and high-altitude pressure and temperature measurements are important for the control of missiles and their accurate direction, as weapons, through the upper atmosphere. But this is a sorry reflection on the times in which we live and on those who are responsible for international relationships. It is in no way peculiar to rocketry. The great trouble is that modern research requires teams of scientists and engineers, great industrial resources to back them up, and such enormous sums of money that only governments can foot the bills. National governments must, therefore, call the tune, at least in so far as the taxpayers allow them to do so; for ultimately, of course, the taxpayer is the man who decides what shall be done. But the taxpayer, as governments know, will more readily pay his taxes to defend his property and himself with military weapons than to explore space. The latter may seem to him a venture which, besides being extremely hazardous, is of little practical value.

The present aims of military research are to improve the efficiency and reliability of rocket motors for guided missiles and aircraft propulsion. But the design of motors for guided missiles, the choice of propellants for use in military actions, the type of propellant feed, are all much different from those needed in spaceflight and accordingly a large part of military work is wasted as far as spaceflight is concerned. But nevertheless, at the present moment, no one else builds rockets!

The first step towards interplanetary flight will undoubtedly be an extension of the high-altitude research programme in order to produce an instrumented satellite vehicle. Whether or not this will emerge as a military venture is in some doubt. Though there appear to be some military advantages to be

gained from the establishment of an artificial satellite repeater station as an expensive control for long-range guided weapons, the development of star tracking and other controls may make the satellite obsolete for that purpose. Moreover, even should the satellite prove to be of definite military value it will, nevertheless, be dangerous to leave its development in the hands of the military. For if that is done research is bound to be national and the whole of the work done by any one nation will be kept as secret as possible from any other. Along that line lies inevitable national competition of the worst kind and perhaps even serious hostility. Besides, if we start on the wrong foot, with national beginnings to space flight, humanity will be storing up an avalanche of trouble for itself in later decades when these researches could very well lead to manned space flight.

If we forbid, by international agreement, the development of space flight by the military establishments of national governments, what are the alternatives ? There is only one—the establishment of some international body to control the work. Such a body could not be financed by any private means, but would have to obtain its funds from the governments of the participating countries. It may well be that it could be organised under the control of the United Nations, perhaps through U.N.E.S.C.O. A body of this nature could be started in quite a small way, acting first by collating information before demanding appropriations for practical work. There must, indeed, be a great deal of classified data which, could it be assembled together, would indicate shorter paths towards interplanetary flight simply because the thinkers who would use it would be freed from the military shackles which force them to be engaged on the problems of producing offensive and defensive missiles. On the other hand, it is fair to say that many people connected with the interplanetary movement think that the time is not yet ripe for an international venture of this kind.

In any case, it would be a dangerous procedure to let the military people bring about space flight. von Braun has said in this connection : " Space flight is too great a project to emerge as the by-product of other work (i.e. guided missiles). While there is no question that such work will contribute to the development of space flight, its development must be the result of a well co-ordinated programme, extending over a number of years. First need is a study analysis taking under advisement each and every phase of the problem."[1]

We could consider this study group formed on this international basis under U.N.O. which would follow a programme somewhat along the following lines :—

(*a*) Collation of the existing relevant data on all subjects needed for the beginning of space flight.

(*b*) Preparation of a detailed list of problems which remain to be solved or of data which is not complete or not sufficiently accurate.

(*c*) Analysis of those problems with a view to deciding which are the most urgent of solution and which must be solved before the rest can be attacked. The establishment of a system of research priorities.

(*d*) Decide which of these research priorities can be usefully solved in the normal development of civilised technology and science, and ask for these to be investigated by the appropriate industries or universities for those normal purposes with a view to the results being made available for the space flight programme.

(*e*) Decide which problems are peculiar to space flight and tackle them in order of priority and possibility of investigation.

(*f*) Having developed sufficient accuracy in techniques then to approach national participating governments, through U.N.O., for the necessary appropriations to build the earth satellite vehicle as an instrument of international scientific research and as a first stage in the space flight programme.

The experimental work of such an organisation would need fairly large funds. It would include continuing high-altitude research, the use of high-altitude rocket planes to test conditions in space leading to free flight in orbit type trajectories, cosmic ray and solar physics, the earth satellite and, ultimately, the deep space probe rockets. This programme could easily occupy the organisation for the next twenty-five years or so. Essential practical work, probably in conjunction with existing establishments, for the realisation of this programme would be the construction of high performance instrumented rockets with good electronic controls which would be capable of becoming the final steps of multi-step earth-to-earth military rockets, the probable developments of national military establishments.

There is, without doubt, even to-day, a great wealth of theoretical knowledge on the subject of space flight. Given sufficient financial backing it is just possible that man could already produce a space ship of sorts. But whether or not such a machine would be successful in its mission is an entirely different matter. The odds would be very heavily against success, for there are still so very many unknowns present. It is not enough to have attained sufficient technical knowledge to build a space ship and fire it ; there must also be confidence that it has a reasonable chance of completing its mission successfully. That can only come when we have tested many theories and assembled a suitable background of practical experience in building, firing and operating large multi-step rockets. The artificial satellite must, therefore, be constructed from experience gained in something more than the high-altitude research programme which is at present being undertaken for military knowledge. Hence, it is very desirable that this programme should be open and not wrapped in military secrecy. Although the high-altitude programme in the United States has released much information for which scientists generally must be grateful, it still must not be forgotten that the ultimate objective of that programme is the obtaining of data for the construction and operation of better weapons. The desirability of making research international cannot be doubted. Only the unrestricted exchange of information and ideas can ensure the free development of space machines. Should development remain in the hands of the military, and there seems to be little indication that it will be otherwise under the present conditions of political chaos, then space flight may only materialise when another war is thrust upon the peoples of the world. Even then it will only come if it is regarded as a military necessity, and there are grave doubts about that. Indeed, it will probably be that future developments of rocket vehicles will be restricted to the construction of those remotely controlled missiles designed to carry atomic explosives from point to point on the surface of the earth or for missiles intended to intercept, if possible, the darting weapons of the enemy.[7, 8]

Finally, it is now very important that some practical work should be concentrated on the preliminary form of artificial satellite.

There are certain conflicting theories which can only be settled by preliminary experiments and until these theories have been proved or otherwise, it is folly to speculate about more ambitious manned laboratories in space or on orbital refuelling stations for interplanetary expeditions. The proposed international research body could have a programme which, although it might be restricted by finance during the early stages, would still produce some encouraging results, ultimately convincing national governments that they should appropriate more money to the space station project as a scientific venture.

Essentially the kind of work envisaged would be the neglected fields as far as military research is concerned. Examples would be such items as :

(*a*) The accurate control of the spatial attitude of the vehicle in free orbit to enable correct entry of the rocket into the satellite orbit.

(*b*) Project designs for the solar power plant capable of generating sufficient power for the electrical services over long periods in space without any maintenance.

(*c*) The development of suitable batteries to ensure electrical supplies during the periods of eclipse.

(*d*) Projected design for the satellite rocket with special reference to the simplification of the developmental work, i.e. the design and construction of motors which can be used for the various stages in tandem arrangements.

(*e*) An overall study of test stands and test equipment required for the satellite vehicle.

(*f*) The design of suitable recording equipment and the planning of a programme of experimentation which the satellite vehicle will undertake in space. The minimising of physical instruments for this programme.

(*g*) The very numerous detail researches into facets of rocket motor operation and control, rocket structure, &c., common to military and civilian projects.

Although modern sounding rockets developed for military research may not reach altitudes at which operation of the earth satellite might be feasible, much of the engineering " know-how " for such vehicles is already available. It needs collating and developing by the appropriation of a sum equivalent to that needed for the construction of perhaps thirty to forty bomber aircraft.

Depending upon the amount of support available there might first be established a programme to construct a minimum satellite carrying a small payload and a metallised plastic bag capable of acting as a passive reflector for radar impulses. Gatland[9] has shown that take-off weight and dimensions for a missile of this nature would be comparable with those of the " A-4 " rocket, the final step being a small high-performance rocket, only a few metres long and about half a metre in diameter. Only after the proved success of a vehicle like this and the experience gained from its launching and operation could a beginning be made with a more ambitious satellite carrying a few hundred kilogrammes of payload to the orbit. For this the necessary " three-step " rocket would have a take-off weight of as much as 100 tons ; it would be about 25m in length and 4m or 5m in maximum diameter, and expendable construction would have to be used to improve the effective mass ratio of the stages.

Although governments and military leaders may be violently opposed to the commencement of non-military rocket work by an international body, the project ought to be started as soon as possible. The way to space flight must logically be travelled through an international body and this can only happen if sufficient engineers and scientists demand

that it should. A beginning to space flight could now be made. The artificial satellite is that beginning and it is in itself a fascinating technical problem of the first magnitude. It is, however, one which engineers of to-day are capable of solving.

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Cutting Tool Nomenclature

THE INSTITUTION OF MECHANICAL ENGINEERS

A GENERAL meeting of the Institution of Mechanical Engineers, arranged in conjunction with the Industrial Administration and Engineering Production Group, was held on Friday, October 30, 1953. At this meeting the following paper was presented and discussed :—

"SOME PRACTICAL ASPECTS OF CUTTING TOOL NOMENCLATURE ARISING FROM RECENT RESEARCH"

By D. F. GALLOWAY, Ph.D., B.Sc. (Eng.), Wh.Sc.

In recent years a considerable volume of research has been carried out to improve the techniques employed in the most widely used metal machining processes. An essential preliminary to all these experiments in turning, milling, drilling, tapping, &c. was accurate control of tool shapes. This necessitated the development of adequate tool-measuring equipment and a comprehensive nomenclature. The nomenclature resulted from an analysis of tool geometry, and an examination of applicable tool grinding methods and inspection equipment. It has been extended to take account of factors which were proved by research to be of considerable practical significance in the ultimate tool performance.

Nomenclatures for the most commonly used types of tool are presented as a basis for discussion together with typical examples of tool geometry, tool grinding methods, and tool inspection equipment which should be taken into account when developing improved nomenclatures. Reference is also made to some of the British, European and American standards.

DISCUSSION

Mr. A. W. Manser, B.Sc. (Eng.), (Member), who opened the discussion, expressed appreciation of the very clear paper which the author had presented on a very vital subject. He was able to support the author's remarks about the question of wear on the flank of the tool. He had appreciated very much the little three-dimensional graph which the author had shown of the flank wear on a carbide tipped tool, which showed very clearly that there were limitations to the often-repeated rule of guidance that it was feed and not speed that did the damage to a carbide tool.

That efficient cutting tools were vital was obvious. The figure which the author had mentioned of 40,000,000 drills a year being purchased in this country made it apparent that it was not only a question of productivity, for if, as was also apparent, those tools were being used inefficiently there must be a tremendous waste of power throughout the country in driving tools which had inadvertently got a negative rake on them. The same remark applied to taps. He had been staggered when he first saw the enormous variation in torque that could be required with two apparently similar taps to the same specification, one of which, however, required over three times the torque of the other to produce the same thread. It was, therefore, apparent that there was here a very big field for saving in power nationally.

On the question of drills, the detailed nomenclature which the author had proposed was at first sight perhaps a bit academic. But the drill was really a complicated bit of geometry for something which apparently was fairly simply generated, and he could not see that one could reduce very much on the nomenclature which the author had proposed. He thought it was necessary to specify something about the relative lip height and it was noticeable that the device which the author exhibited for the commercial checking of drills did allow that to be done, although B.S.S. 328 did not lay down any requirement about relative lip height.

In regard to diameter, he differed from the author, who said that the diameter should be specified at some point along the body of the drill. He would say that the B.S.S. was the more practical way, i.e. specifying across the corner of the drill point.

He felt that if the nomenclature resulted in a tightening up in the precision of manufacture this would not necessarily bring about a rise in the cost of the tools. It was his experience that, so long as the precision was achieved shrewdly, it did not necessarily increase the cost of the article, and, in fact, the reverse was very often the case.

Mr. G. V. Stabler, B.Sc., observed that the basis of the difficulty and confusion over cutting tool angles lay in the original rule-of-thumb workshop methods used to specify tool shape ; to the early lack of knowledge of the fundamentals of cutting action, and to the apparent complexity of different types of tool. They did not yet know the full story of what happened during metal cutting, but the research already carried out justified a marked advance in nomenclature. There would be wholehearted agreement with the author's case for " a clear up-to-date practical nomenclature acceptable to factory personnel, taking into account factors proved by research to be of considerable practical significance in the ultimate performance of the tools." The arguments would be about the proposed terms and whether they were compatible with such requirements.

Tool geometry had been studied by many. Fundamental research had reached completion a few years ago and had been reported to the Institution. Its geometrical results had not been challenged. The author and those responsible for B.S. 1886 : 1952, had followed the old methods and had made the confusion worse confounded. The author's definitions might form the basis of further standard specifications, and it was a duty to see that they were sound now, before publication, and that they did not have to be altered as B.S. 1886 would eventually have to be. The author had ignored the most important practical angles.

If the fundamental angles were difficult to understand, if they were impracticable, if they were difficult to set up in the toolroom, if they were theoretical and were called by Greek letters, if they were numerous, if they did not affect the efficiency of cutting, if they took no account of chip flow, or even if they were any single one of these points, then the author might have had grounds for side-stepping them from a practical standpoint. In fact, the fundamentals were simple to recognise, to define and to set. For any edge they numbered only three. The first one was practically directly proportional to the efficiency of cutting, the second controlled the very practical business of the direction of chip flow. The third had a minor effect on cutting action, but it must be there.

The first fundamental angle of any tool was the rake measured normal to the cutting edge and normal to the rake face. If an adjective was required to distinguish it from a whole host of confusing other possible rakes, then the word " primary " should be used. It was one of the simplest angles to measure and recognise on any tool. Its precise definition was easy by reference to " the relative direction of motion between tool and work " ; its definition with regard to single-point tools, or any other tool, only requiring a simple modification due to the feed angle and the setting angle. Boston in America, in 1926, had been the first to show its direct effect on cutting efficiency, and the speaker had recently confirmed his (Boston's) results in both turning and milling. He had figures, taken from tests, showing conclusive evidence that Boston's original 1926 results applied in turning and milling, and indeed for any tool. This fundamental angle was Merchant's oblique rake, but its geometrical conception had nothing to do with Merchant's shear theory.

The second fundamental was the obliquity or the inclination of the edge with respect to a normal to the direction of motion. Its practical importance was secondary only to the rake, and it controlled the direction of chip flow, a fact which any workman could appreciate in two minutes.

The third fundamental was the clearance angle, and if it was properly and simply defined, no qualification was necessary except to relate it to a particular edge.

None of the British, American or German systems shown in Fig. 1 of the paper included the simple fundamental angles. Their only merit was a certain amount of practical facility of specification and measurement, but the fundamentals were just as easy and had a better degree of that " clarity in visualising " so rightly demanded by the author. The German system came nearest to reality, but unfortunately, in the German system, the rake was specified at, not right angles to the cutting edge, but right angles to the base of the tool, and if the obliquity were changed, that was changed also—bringing in, not a fundamental, but a function of a fundamental. If the German had his plane not at right angles to the base of the tool but at right angles to the rake facing the tool, he would have been dead on in his fundamentals. The American system was the easiest to understand and farthest away from the fundamentals, which led to an enormous amount of confusion in workshops. The recommended British system was practically the worst of all, because the maximum rake had absolutely nothing whatever to do with the cutting action or the chip flow. Why anyone had dreamed of having the maximum rake he could not imagine, for there was not the slightest scientific reason for it whatever.

The workshops had for long created and tolerated a confusion between the terms " clearance " and " relief," a confusion which it was now desirable to eliminate. The author preferred " relief," but he was of the opinion that a full survey would show that " clearance " was the more widely recognised term and that it had a much

more strong claim for retention than had "relief."

Ease of tool grinding was a test of a nomenclature system. The author gave an example which beautifully illustrated the difficulties, mental and practical, caused by specifying two co-ordinate rakes.

Use of the fundamental angles made tool grinding delightfully simple. Students with easily acquired knowledge of the fundamentals but without any tool room experience could set up and grind a single-point tool correctly in a few minutes with no confusion or correction.

[Mr. Stabler then demonstrated with a model.]

This demonstration, he said, showed that there need be no confusion, no calculations, no compound angles, no trigonometry—it was simplicity itself because it was fundamental. Once one got single-point nomenclature correct, it was an easy step to apply the fundamentals to any conceivable tool. The apparent complexity of drills, milling cutters, taps, dies and reamers was much reduced by an appreciation of the fundamentals.

Tool nomenclature should be precisely specified and confusion avoided by tolerating any kind of simplification. The greatest practical simplification was the use of the fundamental angles plus as few as possible of the ancillary angles.

He appealed to the author, to the British Standards Institution, to British industry, to take the seals from their eyes, to use existing knowledge to devise a simple tool nomenclature founded on fundamentals which would earn the respect of the whole practical and scientific world and lead to an acceptable international system.

Mr. I. S. Morton said that anyone concerned with metal cutting research soon found himself hindered by the absence of adequate, consistent and agreed nomenclatures.

The paper referred first to single-point tools and reviewed the British, American and German systems. A single, universally adopted system would be most desirable, and personally he had found the American system the easiest to handle. But the essential requirement was to have universal acceptance of one system, and he hoped that the present meeting would do something towards bringing that about.

He was particularly interested in the section of the paper dealing with drills, having been concerned with the early research mentioned in the paper. He felt that the absence of definitions of lip spacing angle and relative lip height from the present British Standard Specification were to be deplored.

He concluded by briefly referring to the proposed nomenclatures for taps and milling cutters; he was currently interested in research with these tools and to him the appearance of even tentative nomenclatures was very welcome.

Mr. P. Spear said that he was afraid both Mr. Morton and he himself spoke in the discussion at some disadvantage as simple research engineers. However, he ventured to take up the cudgels with Mr. Stabler on two small points.

First, he would have thought that it was not merely the angles which controlled the chip flow. For example, if one considered a simple turning tool, the point was machining at a lower peripheral speed than the outer edge, and surely that difference in peripheral speed had something to do with the direction of chip flow. The same argument applied to any other tool, and in particular to a drill.

Secondly, as regards the question of cutting efficiency. There were to-day and had been for the past decade far too many papers published dealing purely with tool efficiency as a measure of forces, as a measure of angles, as a measure of feed; and far too little attention had been paid to the question of how long the tool would last and how its life could be increased.

On the question of tool angles, as far as most applications were concerned (he would not like to mention any accurate percentage but would say from 50 per cent to 70 per cent of applications for turning tools), he would have thought that one could reasonably consider the base of the tool to be in the horizontal plane, and thus he had normally found the D.I.N. method to be the most convenient, in both research and in the shop, of positioning the top plane, assuming always that the base of the tool was horizontal. It was a purely practical point. If the base of the tool was at an odd angle, he would still prefer to ask the operator to grind like that, giving him angles to suit what was eventually wanted.

One thing that had disappointed him in the paper was that, in his opinion, not enough attention had been paid to the spaces between the teeth, tools, and so on.

Mr. P. Grodzinski said that cutting tool nomenclature had to fulfil two different purposes, and he felt that to have a uniform nomenclature for both respects—(*a*) adjustment and use of the tool, and (*b*) production of the tool—might not lead to a satisfactory solution.

He wished to suggest the following purely geometrical approach, which could then be in a clear line with the requirements in the production of the tool. For this purpose one could at first consider a tool edge composed of three planes which intersected in a common point. The point could later on be rounded off, but the first object was to consider the three planes in their relation to one another and then in relation to the tool shank. The problem of grinding was then solved by making one of the three planes: rake face, front clearance face and side clearance face, a main reference plane—i.e. a main plane in a fixed co-ordinate system—and by determining the angular position of the tool shaft correspondingly. The geometrical problem of finding the relationship to the tool shank had been solved some years ago. The making of the three tool edge planes a reference plane to bring them into contact with the grinding wheel could be solved by the Euler transformation, but needed a more difficult mathematical approach. He did not agree with one contributor to the discussion that one could throw all geometry and trigonometry overboard and arrive at a simple problem; but the problem could, of course, be solved by mathematical means which, although difficult, were quite known.

Mr. H. P. Haslam said that the paper brought to light the great need for an improvement in the nomenclature of cutting tools. At the present time the British Standards were not precise enough in some instances and gave to the manufacturers of the tools too much latitude in the specifications. He was convinced that the nomenclature of the standards should be extended so as to cater for and tie down the manufacturer. He wished to qualify his remarks by saying that they did not refer to all manufacturers of drills and taps, but referred to those who still thought that a hole was a hole and a thread a thread and that the life of the drill or tap did not matter. With the high precision that was given by the makers of machine tools, surely the small tool maker could give the accuracy that was desired.

Mr. Morgan noted that the meeting had heard a good deal from Mr. Stabler about the need for simplicity, but although there was, of course, a good case for simplicity, he felt that the cult of simplicity at any cost could lead to very serious excesses.

The complexity of some of the definitions given in the paper was certain to start a search for simpler alternatives, especially for shop use. In particular, the definition for inclined relief in the twist drill nomenclature did not appear to have much chance of being generally accepted, and the simpler definition for nominal relief angle obviously had much better prospects of being adopted in the shops. The concept of inclined relief was, however, useful for research and development. There was a clear distinction here between the needs of at least two different sets of people. The temptation to draw up a compromise definition was great, but he thought it should be resisted, as a single definition might in the end satisfy no one. Two distinct factors were involved, and they should be considered separately. He thought this was a good illustration of the dangers of over-simplicity.

The author's arguments for the inclusion of flute shape in the drill nomenclature were supported by experimental evidence.

There were some minor differences between many of the definitions contained in the paper and those given in the British Standards for single-point tools and for twist drills. Because these differences were small in themselves they appeared to be in danger of being overlooked, and he drew attention to one or two such definitions.

Mr. A. M. Gunner said that in any line of research it was of the greatest convenience to have an agreed code of notation and symbols for the fundamentals of the subject, preferably at an early stage in the proceedings. The author and his associates at PERA had taken time out to devise a standard system for their researches into cutting tools for machining processes. This should be of great value when it came to writing and comparing reports made within the organisation, especially over a period of time. It was to be hoped, however, that it would find acceptance in a wider sphere and, suitably amended, might form the basis of an Anglo-American standard.

Dr. D. F. Galloway, in replying, said that his main reply to the discussion would be given in writing. Some of the questions which had been raised, particularly in Mr. Stabler's contribution, were sufficiently complex to warrant that. Dr. Galloway did not therefore attempt to touch on all the points, but replied to only some of them.

With regard to Mr. Stabler's remarks, he said that, as Mr. Stabler knew, his work had not been ignored in the research that had been done. One thing which Mr. Stabler would appreciate very well was that the British Standard 1886: 1952 had been issued after the publication of his paper. Quite apart from what the B.S.I. had done, he and his associates had studied Mr. Stabler's work, which was a very good contribution to the fundamentals of cutting. What Mr. Stabler had mentioned was quite right in so far as it was connected with the fundamentals of cutting. His own experience, in trying to get research results and new and improved techniques into industry, was that when one had finished the investigations one had no longer to concern oneself with translating to them the fundamentals of cutting: one had to get to them the fundamentals, or whatever it might be, of tool grinding, tool specification and so on; and it was the facility with which the method lent itself to measuring instruments, to regarding the tool,

when it was being ground and measured, as something apart from the machine, that concerned the man in the shop. He thought this was perhaps one of the reasons Mr. Stabler's contribution in 1951 had not been taken up in actual practice as well as one might have thought it would have been at that time. He did not think they could often have the best of two worlds, namely, keeping right in line with the fundamentals of metal cutting and at the same time getting down to the fundamentals of grinding and measuring the tool.

Mr. Stabler had commented that the paper sacrificed the fundamental cutting approach for a certain amount of practical facility in grinding and measuring. He thought those words of Mr. Stabler's were significant. It was this facility in grinding and measuring which was so fundamental to industry. An effort was being made to influence, say, 5000 factories, and even when they knew that these things existed and saw them, they still had to be persuaded that it was economically desirable to use them very often.

Docks of London

The Institution of Civil Engineers' president for the session 1953–54, Mr. W. P. Shepherd-Barron, delivered his presidential address at the Institution on Tuesday, November 3rd. He gave a historical account of the development of London's dock systems. The first part of Mr. Shepherd-Barron's address described the development of these docks up to the beginning of the twentieth century; the second part, which concerned developments during the twentieth century, is reproduced below, together with a table giving details of the P.L.A. dock system.

I HAVE now traced briefly the evolution of the dock systems and the salient features connected with their construction up to the end of the nineteenth century; at about this time, however, it became apparent that there would be great financial difficulty in securing further dock expansion by the companies and that in order to render this of value, and indeed to obtain the best use of existing accommodation as well as to cater for larger shipping, it would be necessary to deepen the river channels.

Shipping was growing rapidly in size and an era of dock expansion on an even larger scale than before was about to begin in all the major ports of the United Kingdom as well as abroad. In 1900 this matter came before Parliament. The eventual outcome was the constitution by Act of Parliament of the Port of London Authority, which, in 1909, under the chairmanship of Viscount Devonport, took over the assets of the dock companies and assumed the management of the port, including the docks and the river below Teddington, the latter having been formerly vested in the Thames Conservancy.

The first Chief Engineer of the port, Mr. (later Sir) Frederick Palmer, past-president, I.C.E., immediately formulated outline schemes for dock improvement and new construction, which, in large measure, have been followed broadly during the ensuing years, and which were complementary to the extensive deepening of the river and estuary down to the Nore by dredging.

Various improvements were soon put in hand. At London Docks the passage between the Western and Eastern Docks was widened, the jetty in the Western Dock was reconstructed in reinforced concrete with a double-storey warehouse, and new double-storey brick and reinforced concrete warehouses were built on the north quay, which was widened. The Hermitage Entrance was closed and an impounding pumping station built therein, enabling the water level in the dock to be raised to 3ft 9in above T.H.W.

At the West India Import and Export Docks the north quays were widened by 56ft and 20ft respectively, by the construction of open or "false" quays consisting of reinforced concrete cylinders with piles driven therein, surmounted by reinforced concrete beam and slab decking, with precast bracing set into the old walls. This enabled the docks to be deepened by 3ft to 26ft below T.H.W., the bottom sloping down under the open work. Since the old walls were founded on the ballast their stability was not endangered by this procedure, which has since been repeated elsewhere and which has proved a remarkably effective and economical method of achieving greater depth in the docks without reconstructing the older walls. The ballast once again proved its immense value as a foundation material.

New brick and reinforced concrete warehouses were built on the north quay of the Import Dock, partly over the false quay, and new steel transit sheds were erected. False quays and new sheds were also built and the lock from the basin was reconstructed, 300ft long, 80ft wide and 31ft deep below T.H.W. A new impounding pumping station raised the water level in the Import Dock by 2ft.

The Millwall Dry Dock was lengthened to 546ft.

At the Royal Albert Dock, a new impounding pumping station was built and the water level in this dock and the Royal Victoria Dock raised by 2ft 6in. The Western Dry Dock was lengthened to 574ft 6in and widened to a minimum of 82ft at the entrance. On the north side of the Royal Albert Dock the first electric quay cranes were installed.

At Tilbury Docks, where the demand for berthing accommodation had increased, the first stage of a scheme of extension westward of the Main Dock was undertaken. The south quay was lengthened by 1531ft with a return section at the west end. The dock was correspondingly lengthened, with a depth of 42½ft and a bottom width of 300ft. The very soft marsh clay, which could not be drained owing to the proximity of the existing dock, made it impossible to sink trenches from the surface, within which to construct the ordinary type of gravity dock wall. This was therefore formed with monoliths 30ft square, each with four wells, built from mass concrete blocks and sunk to the ballast; the back wells were filled with concrete and the front ones left empty. The new quay, which is 40ft wide, was equipped with three steel and corrugated iron transit sheds, 120ft wide and about 600ft long, with a continuous railway platform at the back, and also with electric quay cranes. The contractors for the works were Topham, Jones and Railton, Ltd.

The largest of the dock extensions undertaken by the Port Authority was the construction of the King George V Dock, to the south of the Royal Albert Dock, and connected thereto by a cutting. This magnificent dock was commenced in 1912, the contractors being S. Pearson and Sons. In the same year, Mr. (later Sir) Cyril Kirkpatrick, past-president, I.C.E., succeeded Mr. Palmer as Chief Engineer, and Mr. Palmer was retained as consultant to the Port Authority.

The dock is 4500ft long, the width being 630ft at the eastern end, tapering to 450ft at the western end, and the depth is 38ft below impounded level, which is 2½ft above T.H.W. At the eastern end a new lock entrance was built, 800ft long, 100ft wide and 45ft deep below T.H.W., to the three sills, with a large bell-mouth approach from the river formed beyond the lock walls by two massive timber leading-in jetties. The lock is provided with buoyant steel gates fitted with crocodiles and rollers and worked by hydraulic rams.

The lock structure and the dock walls were of mass concrete and founded on the ballast or the chalk. At the western end a dry dock was built, 750ft long, 100ft wide and 35ft deep below impounded level. The dry dock was equipped with a floating-ship caisson, an electrically driven pumping station, and a 25-ton dockside crane.

On the south side of the dock seven reinforced concrete dolphins, 500ft long, were constructed to carry electric quay cranes; they left a water space 32ft wide between the wall and the back of the jetties to accommodate barges. On the north side six double-storey warehouses were built of brick and reinforced concrete, with steel roofs and underslung electric travelling cranes. On the quay are electric cargo cranes. Seven single-storey steel transit sheds were built on the south quay, and the entire dock is served by railways and vehicular roads. The first world war occasioned much delay and the dock was finally completed by the Port Authority in 1922, the total cost being £4,130,000.

At Tilbury a cargo jetty was constructed in the river, 1000ft long and 50ft wide, on three rows of reinforced concrete cylinders with piles therein, connected by precast bracing and two heavy reinforced concrete decks, the space between being used as a transit shed. Electric quay cranes are mounted on the top deck, which also carries two railways. The jetty, which was completed in 1921, is connected with the shore by a curved approach. At the outer side a depth of 50½ft below T.H.W. has been provided and the inner side is used by small vessels and barges.

At the western end of the north side of the Royal Albert Dock, three of the transit sheds were replaced in 1920 by a double-storey brick and reinforced concrete building with a steel roof, 1100ft long. The ground floor is used for transit purposes and the upper floor, which is divided into four sections, is insulated and refrigerated.

Adjacent to this, a large six-storey brick and reinforced concrete cold store was built in 1918. The total refrigerated space at the Royal Docks was then increased to about 4,000,000 cubic feet, which is equivalent to a storage capacity of nearly 1,000,000 carcases of mutton.

The dockside cold floor was intended for sorting prior to conveyance to the store on elevated bands, but it was found to be more economical to sort to rail wagon for conveyance to the store. The upper floor of the shed was not therefore used as refrigerated space to any extent until the second world war and since.

Very large warehouses were also built on the north side of the Royal Victoria Dock, between 1920 and 1924, for the storage of tobacco, and two berths were reconstructed on cylinders and piles and equipped to handle chilled beef.

At the Surrey Commercial Docks a scheme was formulated for a large new dock to

cross the middle of the estate and, possibly, a new entrance lock some distance above the Greenland Entrance. The first stage of this, the Quebec Dock, was undertaken in 1923 on the site of the Quebec, Canada and Centre ponds.

An 80ft wide cutting was formed from the east side of the Canada Dock and a triangular shaped dock was constructed between this point and the Russia Dock. A north wall, 1300ft long, and a south wall, 900ft long, were built, the eastern end being left as a slope to allow for future extension. The walls were all founded deep enough to permit the cutting and dock to be deepened to 35ft, but the depth was restricted to 27ft in the first instance. Large timber storage sheds were built similar to those previously built at the Canada Dock and elsewhere. These have open ends and brickwork fire division walls with light steel roofs, and enable timber to be stacked to a height of about 25ft.

The Lavender and Acorn ponds were reconstructed and deepened to 19ft below T.H.W., with a steel sheet-piled wall on the east side, 1670ft long. The Stave Dock—Lavender Dock passage was widened to 55ft and deepened to 23ft. The old Lavender Entrance was closed and an impounding station built therein.

In 1925, Lord Devonport retired and was succeeded as chairman of the Port Authority by Lord Ritchie, whose father had been so prominently connected with its inception.

In 1926, a large scheme of development at Tilbury Docks was put in hand, consisting of the construction of a new entrance lock at the western end of the Main Dock, which was also widened, and of a new dry dock, at a total cost of £2,460,000. The lock was made 1000ft long, 110ft wide, and 45ft 6in deep to the three sills below T.H.W., and was equipped with three pairs of ram-operated tank gates. The lock was aligned at an angle with the river—unlike all the other entrances of the Authority's docks (excepting Shadwell and Surrey), which are almost at right angles to the line of the river. Massive timber leading-in jetties were also built to form a bellmouth entrance.

The dry dock at the eastern end of the Main Dock was also set at an angle to facilitate the entry of large ships and was made 750ft long, 110ft wide at the entrance, and 37½ft deep below T.H.W.

These structures were formed by means of monoliths, which have proved to be a successful mode of construction under the conditions prevailing at Tilbury. New impounding pumps were installed in conjunction with the dry dock pumps.

The Port Authority also provided excellent new facilities for passengers by means of a floating landing stage, 1142ft long, moored in the river to dolphins immediately below the entrance to Tilbury Basin, together with a large baggage hall for Customs examination, adjacent to Tilbury Riverside Railway Station. A length of 300ft of the stage is segregated for cross-river ferries. Covered gangway bridges connect the stage with the hall. Passenger liners, whichever of the dock systems they may berth in, now call regularly at the stage on passage both inwards and outwards.

At the same time, at the West India Docks, the South Dock ship entrance at the eastern end was entirely reconstructed, the new lock being made 584ft long, 80ft wide and 35ft deep to the three sills below T.H.W. New passages were also constructed to connect the Import, Export and South Docks, and the latter with the Millwall Inner Dock; a new impounding pumping station was installed at the west end of the South Dock. All these works were carried out in sheet-piled and timbered trenches with mass concrete construction and cost, in the aggregate, £1,650,000.

When the late Mr. Asa Binns, president-elect in 1946, was Chief Engineer, further schemes of improvement were formulated and some of the works put in hand. The principal of them were at the Royal Docks, where the Royal Albert Dock was deepened to 34ft below impounded level, except at the south quay, and a false quay, 19ft wide, was constructed on the north side.

The Royal Victoria Dock was almost entirely remodelled. Its depth was increased to 31ft, including the invert of the cutting between the Victoria and Albert Dock; a new open-cylinder and sheet-piled quay was constructed at the western end of the south side to replace a dilapidated timber wharf, and at the eastern end the dock was widened and two new monolith quays were built in conjunction with the erection of a large flour mill by tenants. Three other large flour mills, with dolphin or quay-wall berths, had, in pre-war years, also been built by tenants on the south side of this dock.

On the north side, the old solid jetties were beginning to fail by the corrosion of their toe-rods and the sheds had long proved inadequate. In consequence, the jetties were cut back and a new straight open quay, 3300ft long, was built. It consisted of three rows of reinforced concrete cylinders with piles and a heavy beam-and-slab superstructure with sheet piling at the back. The spaces behind this quay were reclaimed by pumping with ballast dredged from the dock,

Particulars of Docks of the Port of London Authority

Dock group	Distance below London Bridge, miles	Totals: Area of estate, acres	Totals: Water area, acres	Totals: Length of quays, miles	Docks	Max. depth, feet	Max. W.L. above T.H.W., feet	Lock entrance: Length, feet	Lock entrance: Min. width, feet	Lock entrance: Depth to centre of sill below T.H.W., feet	Dry docks: Length, feet	Dry docks: Min. width, feet	Dry docks: Max. depth over blocks, feet
St. Katharine	0·66	25	10·10	0·94	Basin	18	—	180	45	28 outer	—	—	—
					Western	18	—	—	—	24 inner	—	—	—
					Eastern	18	—	—	—	—	—	—	—
London	0·86 to 1·94	100·25	34·67	2·97	Hermitage Basin	25·25	3·75	—	—	—	—	—	—
					Wapping Basin	23	3·75	170	40	23	—	—	—
					Western	23·75	3·75	—	—	—	—	—	—
					Tobacco	24·75	3·75	—	—	—	—	—	—
					Eastern	24·75	3·75	—	—	—	—	—	—
					Shadwell Basin	25 and 28	3·75	350	60	28	—	—	—
Surrey Commercial	1·81 to 3·56	381·50	134·48	8·88	Basin	27	—	250	50	27·25	—	—	—
					Albion	27	—	—	—	—	88·25	22·5	7·25
					Canada	27	—	—	—	—	—	—	—
					Quebec	27	—	—	—	—	—	—	—
					Russia	19	—	—	—	—	—	—	—
					Island	23	—	—	—	—	—	—	—
					Stave	19 and 21	—	—	—	—	—	—	—
					Lavender	19	—	—	—	—	—	—	—
					Lady	19	—	—	—	—	—	—	—
					Norway	19	—	—	—	—	—	—	—
					Greenland	32·5	—	550	80	35·25	—	—	—
					South	27	—	220	48	27	—	—	—
West India and Millwall	2·80 to 6·31	466	132·88	6·71	Import	26 and 29	—	—	—	—	—	—	—
					Blackwall Basin	26	—	480	60	30	—	—	—
					Export	26	—	—	—	—	—	—	—
					Junction	25	—	—	—	—	—	—	—
					South Millwall	29	—	584	80	35	—	—	—
					Inner	29	—	—	—	—	—	—	—
					Outer	28	—	450	80	28	546·42	65	24·12
East India	6·71	49	23·34	1·16	Basin	32	—	100	64·5	31	—	—	—
					Import	24	2	—	—	—	—	—	—
Royals	7·1 to 10·59	1112·5	235·85	11·05	Royal Victoria	28 and 31	2·5	325	80	20·5	—	—	—
					Royal Albert	29·5 and 34	2·5	—	—	—	574·5	80	22·75
											500	62	22·75
					Royal Albert Basin	34·5	2·5	550	80	30	—	—	—
								550	80	36	—	—	—
					King George V	38	2·5	800	100	45	750	100	35
Tilbury	24·78 to 26·22	725	103·79	3·95	Basin	Tidal	—	695	79·5	44 outer	260·5	59·83	26·83 (T.H.W.)
										38 inner	119	70	31·75 (T.H.W.)
					Main	38	—	—	—	—	560	59·83	26·83
											698·3	70	31·08
											752·3	110	37·5
					East Branch	38	—	—	—	—	—	—	—
					Centre Branch	38	—	—	—	—	—	—	—
					West Branch	38	—	—	—	—	—	—	—
					Main Dock	42·5	—	—	—	—	—	—	—
					Extension	—	—	1000	110	45·5	—	—	—
Totals		2859·25	675·11	35·66									

and on the ground thus formed five large three-storey warehouses were built together with railways and a new vehicular road. The total floor area of these warehouses is 26 acres.

The total cost of these improvements was £1,850,000, and various similar, but smaller, improvements were carried out at the West India, Millwall and Surrey Commercial Docks.

The war put a stop to further improvements and, indeed, was the cause of an immense amount of widespread damage and destruction. Much of this was the result of fire among the older timber-floored warehouses at the upper docks and the timber in store at the Surrey Commercial Docks ; there was also a great deal of damage by high-explosive.

In 1939, Lord Ritchie retired, and his successor, Thomas Wiles, in 1946. The present chairman of the Port Authority, Viscount Waverley, and honorary member of the Institution, took office in 1946.

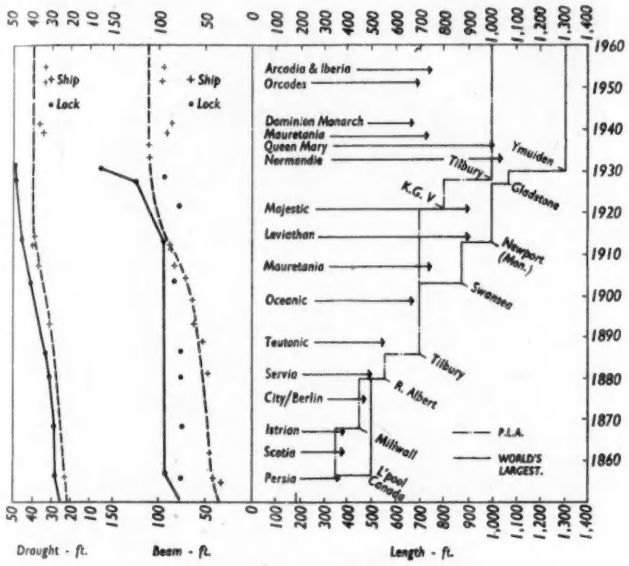
Very rapid strides have been made with the repair and reconstruction of the docks and buildings and the opportunity has, of course, been taken to do so on the most up-to-date lines and to effect as much improvement as possible.

Besides this, further large works of development are in hand, principally the reconstruction of the lower entrance lock of the Royal Albert Dock, the construction of a new quay and shed on the north side of the Main Dock at Tilbury and of warehouses at West India Dock, and the widening of the Canada-Greenland Cutting at Surrey Commercial Docks.

Analysis

Finally, I would like to make a few remarks regarding the size and growth of the shipping for which all these vast dock works have been constructed and which will be the all-important factor in the design of future works. The largest vessels using the port at the commencement of the nineteenth century were East Indiamen of 1550 tons burthen, 199ft long and 43½ft beam, but they were exceptional and the majority of the vessels were of 300 to 400 tons burthen. Ship sizes tended to decrease after the end of the Napoloenic Wars and it was not until 1838 that a larger ship was built, this being the Transatlantic wooden paddle steamer " British Queen "—2016 tons, 234ft long and 37½ft beam. In 1853, the P. and O. Company launched their iron screw steamer, " Himalaya "—3437 tons, 340ft long, and 44½ft beam.

During the second half of the nineteenth century, the size of shipping increased steadily and so consequently did that of the lock entrances which were required. Comparison of the tonnage of old vessels with ships of to-day is made difficult by the changes in the rules of measurement, for until 1835 tonnage was calculated on an empirical formula which disregarded both depth and fineness ; from 1836 to 1854 a simple volumetric rule was in use and it was not until 1855 that the basis of the present volumetric system was established. The diagram shows the dimensions of certain of the largest ships at various dates since then and also of certain of the largest ships for which the Port of London has had to provide during recent years.



Lock and Ship Development from 1850

The diagram also shows the dimensions of the lock entrances constructed at the docks during the same period, together with those of the largest locks built for commercial shipping throughout the world.

It will be seen that the London entrances have, except for the very largest North Atlantic passenger liners, always been not only adequate for the largest ships trading to London, but have provided a considerable margin at the date of their construction ; in some cases, however, the size of shipping has eventually outstripped that of the entrances.

The Upper Entrance at Tilbury, although built in 1928, still provides a good margin, especially in length, over the largest present-day vessels of the P. and O. and Orient Lines, and the King George V Entrance, now thirty years old, has on one occasion accommodated the present R.M.S. " Mauretania," which was built to conform with the dimensions of this entrance ; the next largest ship which regularly docks at this entrance is the " Dominion Monarch," of the Shaw, Savill and Albion Line, for which there is a good margin.

Analyses of shipping at the Royal Docks and at the West India Docks, made a few years ago, have shown that the number of vessels of the largest sizes are small by comparison with the total and that a second entrance of more moderate dimensions than the largest is a very valuable asset at a dock system, since it enables more shipping to be docked on a tide and conserves impounded water. For instance, it was found that, from consideration of size alone, the Gallions Lower Entrance of the Royal Albert Dock could have locked as much as two-thirds of the number of ships using the Royal Docks and a somewhat similar proportion could have been locked at the Blackwall Entrance of the West India Docks ; it is seldom, if ever, possible economically to justify the provision of two entrances of the largest size at a dock system, but, on the other hand, it is of the utmost importance that the dimension of such entrances should be determined from a careful and generous estimate of the sizes of the largest classes of ships that will be built in the future for the trade of the dock.

Once built, these structures can seldom be altered, except at very great expense, and the additional cost of providing a good margin is relatively not great. Past history shows that, in every case, planning in this way has been fully justified. The cost of ships and the value of the cargoes they carry are to-day so great that the capital cost of adequate port works, while very heavy, is not unduly large by comparison and may be fully justified in the national interest by the economies that the larger ship effects by reduction in running and transportation costs.

An important matter in the determination of the dimensions of entrances is the relationship of beam to length of ships and this has altered considerably during the past fifty years. Existing port works both at home and abroad have often imposed limitations upon the increase in the size of ships, especially of length, by reason of locks and berths available, and of draught by reason of the depth of channels, which often are difficult and costly to deepen.

The only freedom available to the shipbuilder, therefore, has been in beam ; this may be related to length by the formula :

$$\text{Beam} = \frac{\text{length}}{10} + C$$

The value of the factor C was about 7 in 1900, but has steadily increased and is now sometimes as high as 19, and, I understand, may even increase to about 24 in the future.

The question of " the depth of water to be provided in seaports, their entrances and berths in relation to the present trend in shipbuilding as regards dimensions and speeds of large ocean-going liners, cargo ships and tankers " is at present being studied by the Permanent International Association of Navigation Congresses, on the British National Committee of which the Institution is represented.

When formulating his proposals for the improvement of the Port Authority's docks in 1910, Sir Frederick Palmer had these considerations prominently in mind and in his comments expressed his only fear, which was that he might repeat the former mistake of building certain entrances too short for future requirements. He considered that such mistakes had repeatedly hampered shipowners in the size of vessels necessary for their trade and could involve very heavy expenditure in reconstruction which could not give the same advantageous results as the original provision of adequate large entrances. His foresight and that of the Port Authority in building the magnificent entrances he designed have been amply justified.

Cambridge Symposium on Mechanics.—In September last a symposium was held in the Engineering Department of Cambridge University to consider " the teaching of mechanics, vibration and control." Visitors were invited from all the Departments of Mechanical Engineering in the Universities and colleges of University standing, of the United Kingdom. Some members were also invited from large firms in order that the industrial point of view should not be lost. During the symposium periods were devoted to discussion of the following subjects : how much mechanics ought every engineer to know ; entrance standards; undergraduate courses ; laboratory work ; teaching techniques ; advanced and post-graduate courses ; the approach abroad ; and a concluding session covered a number of topics.

Death of Mr. George William Clarke.—Mr. George William Clarke, of Standard Telephones and Cables, Ltd., died on October 1st, aged sixty-six years. Mr. Clarke started with the company as a tool draughtsman in 1912, and he occupied various positions before becoming the manufacturing engineer responsible for apparatus and equipment projects in the London (formerly European) general manufacturing department.

NON-FERROUS CENTRIFUGAL FOUNDRY

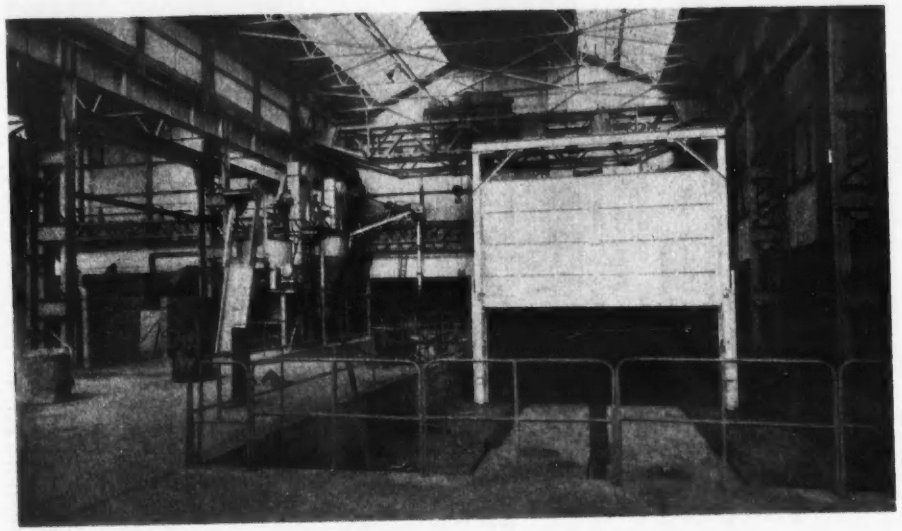


Fig. 1—Sand Plant and Drying Oven

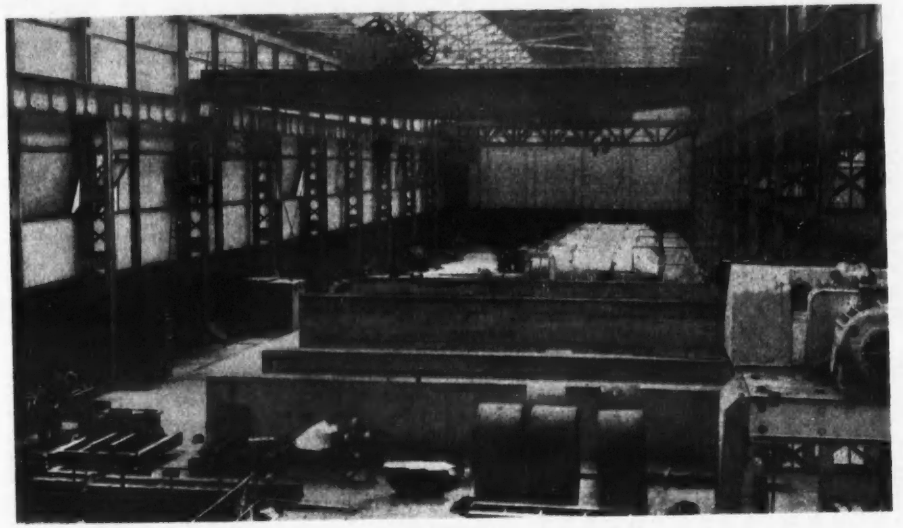


Fig. 2—Centrifugal Castings Bay

Fig. 3—Oil-Fired Melting Furnaces

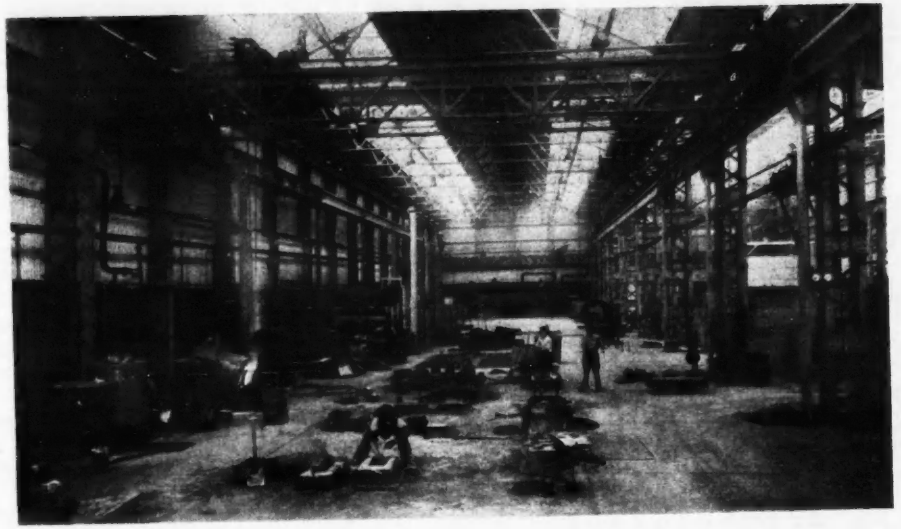


Fig. 4—Small Foundry Bay

Non-Ferrous Centrifugal Foundry

A new foundry mainly for the production of non-ferrous centrifugal castings was opened last week by Millspaugh, Ltd., Sheffield. The foundry, which is equipped to produce probably the largest castings of their kind made in the world, is described and illustrated.

ON Wednesday of last week, October 28th, we attended the opening of a new foundry of Millspaugh, Ltd., at the Alsing Road works in Sheffield. That firm was founded in 1933 by Mr. W. H. Millspaugh, who had previously developed the centrifugal casting process in the United States for the manufacture of large non-ferrous tubes. From the beginning the new firm was closely associated with Hadfields, Ltd. Its first foundry was accommodated on ground adjacent to the East Hecla steel department of that company, and its machine shops occupied a bay of Hadfields' No. 4 machine shop. In the years before the war markets were found for liners for ships' propeller shafts and, more particularly, for suction rolls for papermaking machines. After the war the firm became a direct subsidiary of Hadfields, Ltd., and the development of the papermaking machinery and general engineering side of the business was encouraged. But when nationalisation of the iron and steel industry threatened to occur the firm was hived off. A new administration block was completed at the Alsing Road works and it became essential to find a new site for the foundry. In June, 1952, Hadfields, Ltd., vacated its old forge and those premises became available. They are conveniently situated alongside existing machine and erecting shops of Millspaugh, Ltd.

Photographs of the new foundry are reproduced on page 588. The buildings are of brick and corrugated sheet construction. There are two bays, one 58ft wide and the other 50ft wide, both 350ft long. The wider bay contains four melting furnaces, two casting machines, the mould-making pit and the drying stove and has overhead cranes of 50 tons, 35 tons and 30 tons capacity. In the smaller bay there are the metal stores, sand stores, a small casting machine, and a well-equipped jobbing foundry.

The sand mixing plant for the centrifugal casting foundry, together with the mould drying stove, is illustrated in Fig. 1, and Fig. 5 shows the ramming up of a mould. The sand mixing plant was supplied by Augusts, Ltd. There is an August-Simpson sand mill with an automatic charging hopper and a metering device for adding moisture. The hourly output is in the neighbourhood of 5 tons. The mill discharges into a hopper, which empties itself on to a turntable, from which sand is ploughed off as required and elevated by a bucket elevator to a swivel-mounted belt conveyor which feeds sand to the flasks. Both new and reclaimed sand is used.

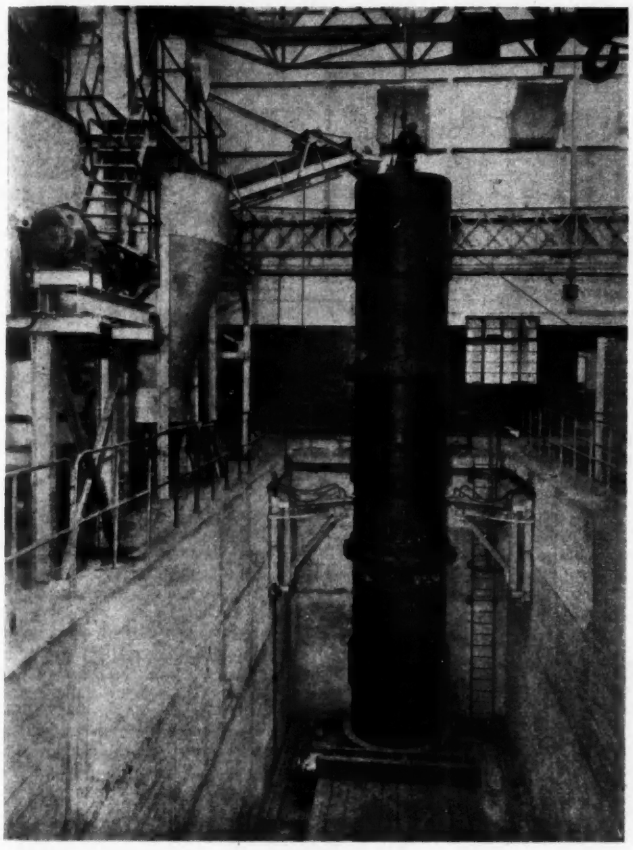


Fig. 5—Ramming Up a Mould

For the making of a mould a cylindrical flask is first fitted with a "stop-off," set in place according to the length of casting it is desired to make. It is then upended, as shown in Fig. 5, dropped into the pit, 20ft deep, shown in that engraving, and mounted on a 7ft diameter turntable, upon which it is centred by a spigot. Pneumatically operated steadies hold the upper part of the flask true. A plug or pattern made of wood or metal is lowered by the crane into the flask and located centrally on a spigot on the "stop-off." Then, as sand is fed into the annular space between the pattern and the flask from the overhead swivel conveyor, the turntable is rotated. From a platform above the mould operators steady a pneumatic rammer which consolidates the sand. Sand is rammed to the top of the pattern, which is then lifted 3in or 4in and the process repeated until the mould is complete. The plug is then stripped out and the mould inspected. Depending on the size of the mould, blacking is added by the use of circular brushes or by hand. Lastly, the completed mould is lifted out of the pit by a crane and laid down with its axis horizontal on the bogie of the mould drying stove. The latter was manufactured by Modern Furnaces and Stoves, Ltd., and works on the recirculation system.

When the mould is dry the flask is placed upon the rollers on one or other of the two casting machines, depending upon its size. The concrete walls of the shallow pits containing the casting machines can be seen in Fig. 2. Each of these machines has six rollers arranged in pairs, which run underneath the three bands formed in the flask and clearly visible in Fig. 5. One of the central pair of rollers is driven by electric motor through vee belts, the remaining rollers being idlers. The flask is located axially by vertical spindle rollers bearing on the flanges of the central band. Before rotation begins a front plate is sealed into position over the open end of the flask, a canopy is rolled into position over the machine and the spout of a pouring basin, placed in front of the machine, is entered into the mould through an orifice in the front plate. When the desired speed of rotation has been reached metal is poured from a ladle through the pouring basin into the mould, whilst water sprays cool the outer surface of the flask. When the casting is black the flask is removed from the rollers and placed on a carriage in the knock-out, a large fabricated framework vibrated by pneumatic means. Once the sand is loose the flask is butted up against a stop in the floor and the casting drawn out of it by the use of a wire over a snatch block to one of the overhead cranes.

All the alloys used in the foundry are non-ferrous. Material arrives in the form of ingots or process scrap. The latter, consisting mainly of turnings, borings and drillings from the machine shop, is passed through a Dunford and Elliot rotary louvre drier and over a magnetic separator.

In the centrifugal casting foundry there are four Stein and Atkinson oil-fired rotary tilting furnaces, each of 6-ton nominal capacity—Fig. 3. The products of combustion are removed by downtakes which lead to a common flue ending in an 80ft high chimney. Metal is transported to and charged into the furnaces by a Conveyancer fork-lift truck. The furnaces are charged and tapped from the front or burner end and slagged from the exhaust end. Using "Britoleum" fuel oil through Urquhart burners, the firing rate can be as high as 45 gallons per hour. Preliminary trials indicate that 5 tons of gun-metal ingot can be melted from a hot start in 1½ hours at a firing rate of about 30 gallons per hour.

The melting plant in the small foundry bay—Fig. 4—consists of three Waterhouse 600 lb capacity crucible furnaces and one Monometer 400 lb capacity furnace, all four oil-fired.

The new centrifugal foundry is capable of producing castings ranging from 5in o/d by 10ft long up to 60in o/d by 31ft long, possibly the largest castings of their kind in the world.

The official opening of the new foundry was conducted by the Lord Mayor of Sheffield, Councillor Oliver S. Holmes. The party was then able to see one of the furnaces tapped and a centrifugal casting poured. Afterwards a tour was made of other Millspaugh shops, in which the machining of suction rolls for papermaking machines and the erection of a paper mill were observed.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1

METHODS OF PROTECTION AGAINST CORROSION FOR LIGHT-GAUGE STEEL USED IN BUILDING

No. P.D. 420 : 1953. Price 3s. This revised document deals with the protection of mild steel components not exceeding 10 S.W.G. (0·128in) in thickness used in the general building construction. The procedures recommended are not mandatory, but are intended for the guidance of those concerned with the protection of light-gauge steel. If the constructional use of light-gauge steel in building is to be justified, adequate standards of protection are necessary since the permissible design or working stress for a reasonable factor of safety depends far more on efficient protection against rusting than is the case with heavier sections. In the main, the procedures are to be regarded as providing the minimum degree of protection desirable for the given conditions of service.

Six grades of protection are recommended and guidance in their use according to conditions and exposure is given. The basis of the recommendations is given in Part 6, which describes the various atmospheres encountered. The importance of avoiding design and structural details conducive to corrosion is emphasised.

NICKEL ANODES AND NICKEL SALTS FOR ELECTRO-PLATING

Nos. 558 and 564 : 1953. Price 4s. This publication is a revision of standards which were originally published separately in 1934. It gives details of composition together with limits of impurities and includes detailed methods of analysis.

Control System for Motor-Driven Blast-Furnace Turbo-Blowers

A variable-speed d.c. drive for blast-furnace turbo-blowers has been developed, using grid-controlled mercury-arc rectifiers and a standard form of pneumatic regulator to control the motor speed and, therefore, the quantity of air delivered. The first installation of this kind was completed at the Rotherham works of the Park Gate Iron and Steel Company, Ltd., and has been in operation for some months.

TWO reciprocating blowers operating on blast furnace gas were recently replaced by motor-driven turbo-blowers at the Rotherham works of the Park Gate Iron and Steel Company, Ltd. Motor-driven equipment was chosen because bulk electricity supply was available from the national grid, with an additional supply from the works generating station. The basic principle of the variable speed drive developed and installed by The General Electric Company, Ltd., is that the control function should be initiated by pneumatic regulators and that grid control of the rectifier output voltage should be used to translate the demands of the regulators into the required speed variation of the blower motors.

The blowers (Fig. 1), which were manufactured at the company's Fraser and Chalmers Engineering Works, Erith, are designed each to deliver 30,000 cubic feet of free air per minute at an outlet pressure of 10 lb per square inch gauge or 25,000 cubic feet per minute at 15 lb per square inch gauge, under atmospheric conditions of 30in Hg and 60 deg. Fah. The approximate blower characteristics are shown in Fig. 3.

Each blower is a multi-stage, single-flow, centrifugal uncooled machine, having four 42in diameter impellers. The construction is orthodox, with cast iron intermediate casings for each high-pressure stage; these casings, together with the inlet and discharge casings, are split on the horizontal joint, so that the upper half can be lifted for inspection of the rotor without disturbing any other part of the blower. Shaft and inter-stage packings are of labyrinth construction; the impeller discs, side plates and blades are of steel and the blades are of channel section riveted to the disc and side plate.

Each blower is flexibly coupled through double helical, 4·42 to 1, speed increasing gears to a 2200 h.p., 770/580 r.p.m., d.c. motor. Two grid-controlled, steel-tank mercury-arc rectifiers provide the 750V supplies to the motors, each rectifier being a twin-cylinder equipment rated at 1740kW. The rectifier cylinders are of The General Electric Company's standard pumpless, air cooled design and each unit is fitted with field anodes for the excitation of the corresponding blower motor.

The high-voltage supplies to the rectifiers are controlled by an 11kV duplicate busbar metal-clad switchboard. One set of busbars is connected to the incoming 11kV supply, while the second set is fed from the works generating station through a 3900kVA transformer which steps up the voltage from 3·3kV. Each of the incoming feeders is equipped with a 400A, oil-immersed, triple-pole isolator, and the outgoing feeders to the rectifier transformers are fitted with spring-operated oil circuit breakers having a breaking capacity of 250MVA. Either or both of the blower equipments can, therefore, be supplied from either of the incoming feeders.

In response to the demands of the blowers, as determined by the pneumatic regulators, the speeds of the blower motors are varied by controlling the voltage of the outputs from the rectifiers. The control scheme is exactly the same for both blowers and the basic essentials of the system are illustrated in the block schematic diagram (Fig. 2).

Two phase-shifting transformers are connected in the grid circuit of the rectifier. The first transformer is driven by a small geared motor unit which is controlled by "raise" and "lower" push buttons mounted on the front of the grid control cubicle. The output of this unit is fed into the primary of the second phase shifter which is automatically operated by an Askania constant volume regulator. The secondary winding of this phase shifter is connected to the primary of the grid pulse transformer, the six-phase output of which is fed to the grids of the rectifier. This transformer is designed to provide an output voltage of approximately square wave form, the steeply rising wave front ensuring precision in timing the firing of the main anodes. The negative bias voltage for the grids is supplied, through a stabilising potentiometer, by a three-phase, bridge-connected metal rectifier, the input to which is provided by the negative bias transformer. The 230V primary supply for both the negative bias transformer and the motor-operated phase shifter is obtained, via an auto-transformer, from a tertiary winding on the main transformer.

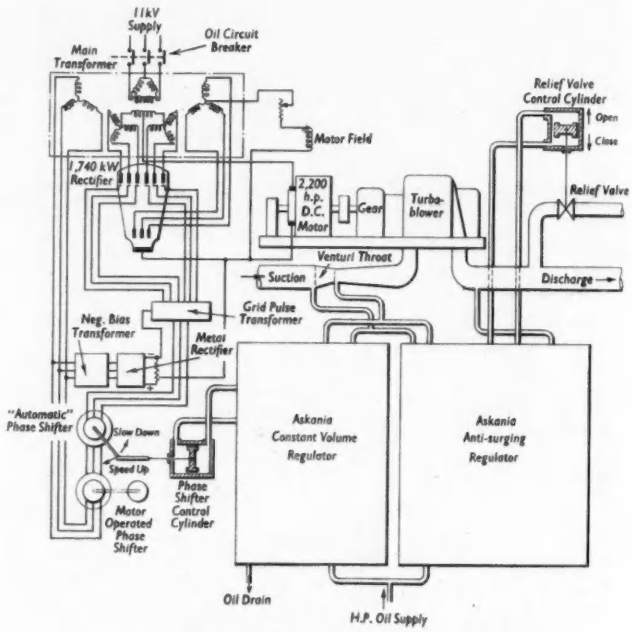


Fig. 2—Simplified Diagram of Control Scheme

During starting, the motor-operated phase shifter is used to increase the rectifier output, thereby raising the speed of the blower motor.

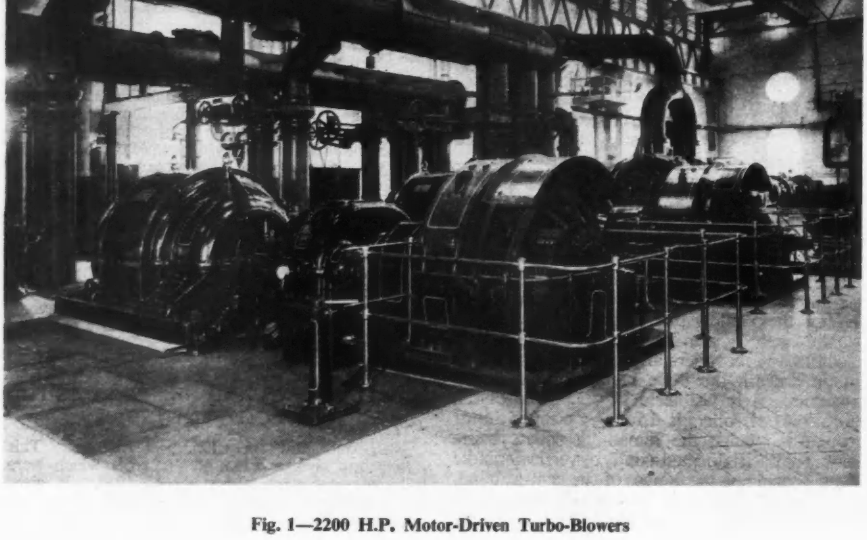


Fig. 1—2200 H.P. Motor-Driven Turbo-Blowers

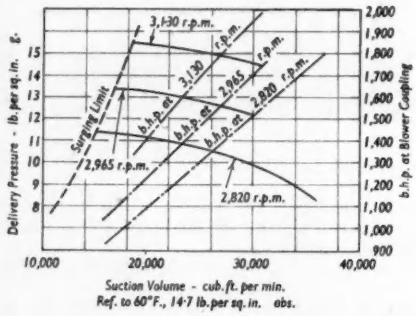

3,130 r.p.m.
2,965 r.p.m.
2,820 r.p.m.
Surging Limit
b.h.p. at
Delivery Pressure - lb. per sq. in. g.
b.h.p. at Blower Coupling
Suction Volume - cub. ft. per min.
Ref. to 60°F., 14·7 lb. per sq. in. abs.

Fig. 3—Approximate Turbo-Blower Characteristics

As the blower speed increases, the automatic phase shifter comes into operation and eventually takes over complete control, varying the speed of the motor so as to maintain a constant volume air supply to the furnace.

The volume of air entering the blower is measured by means of a Venturi throat in the suction main, giving a differential pressure of 4in water gauge at maximum volume. The elements of this differential pressure are applied to the opposite sides of a flexible diaphragm

in the Askania constant-volume regulator. The resulting force on the diaphragm is transmitted by a push rod to a jet pipe, pivoted at its lower end and supplied with high-pressure oil. Opposite the nozzle of the jet pipe there are two adjacent orifices connected through pipes to opposite ends of the phase shifter control piston which is mechanically linked to the rotor of the automatic phase shifter. The compression of a control spring is adjusted so that, if the volume of the air flow is at the value required, the forces exerted by the spring and the push rod are balanced when the jet pipe is in the mid-position. Under these conditions the oil jet issuing from the nozzle will impinge equally on the two orifices, so that equal pressures will be transmitted to each end of the

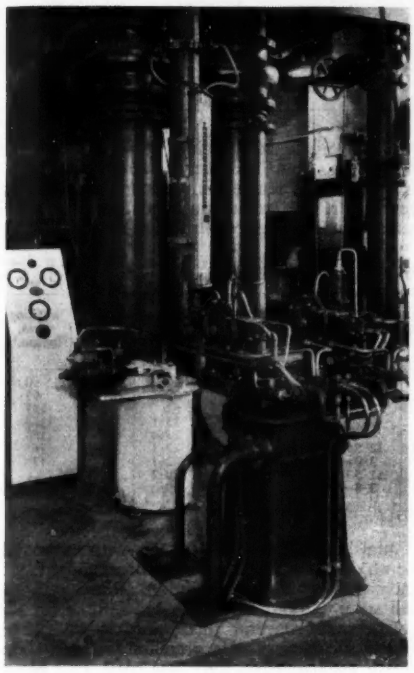


Fig. 4—Regulators and Automatic Phase Shifter

control cylinder, and the piston will remain stationary. There will, therefore, be no movement of the rotor of the phase shifter and the blower will continue to run at constant speed.

Any tendency for the air flow to diverge from the desired value causes a change in the pressure on the diaphragm and a movement of the oil jet to the left (for pressure rise) or right (pressure fall). This change causes the control piston to move to the left or right and the resulting movement of the phase shifter is such as to alter the blower speed and thereby restore the air flow to the pre-set value. When the required value of air flow is re-established the jet pipe returns to the mid-position and the regulator is then in equilibrium. It will be evident that the degree of compression of the control spring, which can be adjusted, determines the required air volume to which the unit will regulate. The system is prevented from hunting by the Askania anti-hunting equipment or overtaking gear.

A second Askania regulator, operated by differential pressure across the Venturi throat, is provided to prevent surging of the turbo-blower by operating a relief valve in the discharge main. It blows off to atmosphere sufficient air to ensure that the volume handled by the blower is never less than the surging volume.

The setting of the constant volume regulator is such that there can be no interaction between the two regulators when surging conditions are approached.

The two regulators are mounted side by side on a cast iron pedestal, which may be seen in the foreground of Fig. 4. This illustration also shows the automatic phase shifter with the control cylinder supported on an extension of the top plate. The oil pump motors, which are energised from a 440V, three-phase supply, are

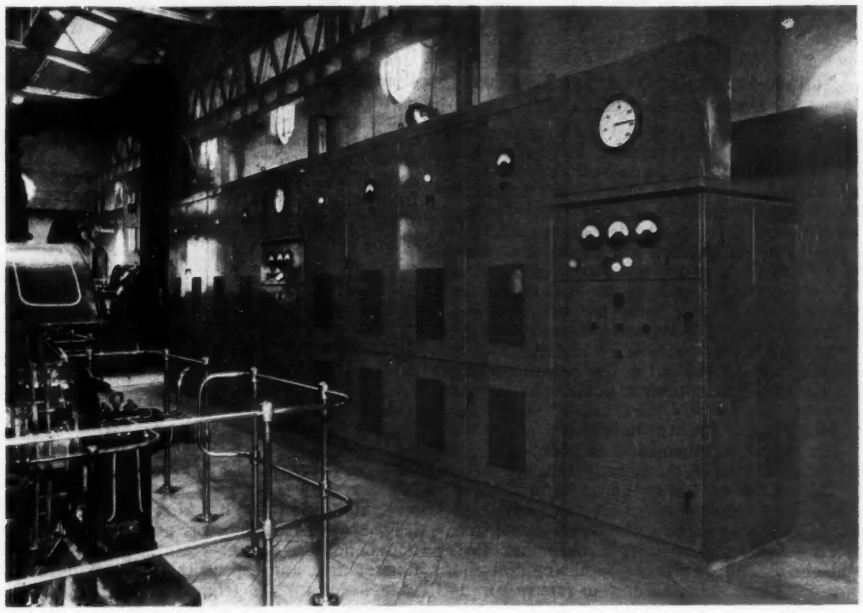


Fig. 5—Grid-Controlled Mercury-Arc Rectifiers Supplying Motors

controlled from a panel adjacent to the phase shifter.

The rectifier cylinders are housed in sheet steel cubicles (Fig. 5), each with its own auxiliary apparatus including anode chokes, anode fuses, cooling fan and ignition and excitation equipment. The grid control equipment for each pair of cylinders, including the motor-operated phase shifter, is enclosed in a separate sheet steel cubicle which also houses various protective gear. On the front of this panel are mounted an ammeter, a voltmeter, a speed indicator, operating switches and indicating lamps, while the air flow volume is indicated on a meter mounted above the cubicle.

To start either blower, the appropriate circuit breaker is first set to the busbars selected. The isolator and breaker are then closed to connect the supply to the main transformer from which the rectifier main anodes are energised. At the same time the field supply transformer, the secondary winding of which is connected to the three field anodes, is energised from a tertiary winding on the main transformer. Thus, the motor field is energised as soon as ignition takes place. The grid control gear is also supplied from the main transformer tertiary winding so

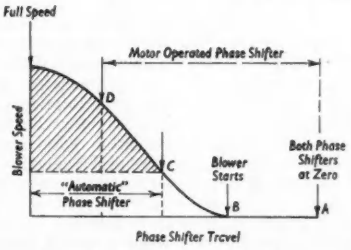


Fig. 6—Principle of Operation of Two Phase Shifters

that the motor-operated phase shifter can now be brought into operation by pressing the "raise" push button on the front of the grid control cubicle, thus starting the phase shifter motor.

The mode of operation of the two phase shifters is shown graphically in Fig. 6, from which it will be seen that at point *A*, with the phase shifters at zero, the blower is stationary. As the motor-operated phase shifter is advanced to point *B*, voltage appears at the motor terminals and the blower starts to rotate. It gathers speed with increasing voltage and, by the time point *C* is reached, it will be delivering air in sufficient quantity to bring the Askania regulator into operation. The pressure on the "raise" push button is maintained until the motor-operated phase shifter has reached the limit of its travel, corresponding to point *D*, as indicated by a lamp on the front of the control cubicle. The automatic phase shifter then assumes complete control, the motor-operated unit remaining in its limiting position.

On shutting down the plant, the automatic phase shifter returns to its original low-voltage position, but the motor-operated unit, although de-energised, remains in its maximum voltage position, since there is no supply to its driving motor. To restart the blower motor after reconnecting the supply to the main transformer, this phase shifter must be returned to its original position by pressing the "lower" push button, an interlock being provided to ensure that the rectifier cannot be ignited until this operation has been completed.

Crystal Palace Television Transmitting Station

THE television transmitters for the B.B.C.'s new transmitting station at Crystal Palace will be supplied by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex. In the interests of continuity of service, the station will have two 15kW vision transmitters designed for parallel operation. By using a high-gain aerial system the station will be capable of producing an effective radiated power of between 200kW and 250kW, compared with e.r.p. values of 100kW for each of the four post-war high-power stations and 34kW for Alexandra Palace. Parallel operation will also be applied to the two Marconi 4½kW sound transmitters which will be amplitude modulated.

The aerial system will be mounted at the top of a self-supporting steel mast 640ft high, giving an aerial height of 1000ft above sea level. Although the higher power of the new station will not greatly increase the area already served by Alexandra Palace, it will give a much stronger and more interference-free signal, in those parts of the London area where the interference level is high, and along the South Coast.

The vision transmitters are of recent design and incorporate a new tetrode valve made by the English Electric Valve Company, Ltd. The use of this valve simplifies the design of the transmitters and results in a reduction in size.

Adjustments to the transmitter will be effected from the adjoining control room which will be equipped with a special desk having controls for starting and stopping both vision and sound transmitters. The transmitter drive, input and monitoring equipment will be in the same room.

Transmissions from the new station will be vertically polarised, and on the same frequencies as those used at Alexandra Palace, namely, 45 Mc/s for vision and 41·5 Mc/s for sound. The new station will take about two years to build.

Metallurgical Topics

Notched-Bar Impact Tests and Behaviour Under Multi-axial Stress

It is well known that two steels, or one steel after two different treatments, may give widely different results in notched-bar impact tests, although their tensile properties are practically the same. The question arises as to how far their behaviour under the complex multi-axial stress relations of the notched-bar impact test reflects their behaviour under multi-axial static stress in the absence of notch effect—that is, whether differences in impact value are still significant if neither notch nor impact is involved. Light is thrown on this question by the results of an investigation carried out in the research department of the Fr. Krupp works at Essen in the years 1941–44, and recently published by H. Bennek, E. Houdremont and R. Mailänder.*

The chemical composition and heat-treatment of the steels used in the investigation are shown in Table I. Steel 1 is a non-ageing mild steel; steel 2 is an ordinary killed basic Bessemer steel, and steel 3 an austenitic chromium-nickel steel. Steels 4–6 comprise two nickel-chromium steels and one chromium-manganese-silicon steel after heat-treatments differing only in rate of cooling from the tempering temperature, thus maintaining similar metallurgical properties (including segregation) in the tough and temper-brittle conditions, i.e. in conditions which show practically equal tensile strength and differ essentially only in impact value. These steels gave impact value/temperature curves shown in Figs. 1 and 2. Steels 1 and 2 showed a steep fall in impact value with reduced temperatures, the transition from tough to brittle fracture occurring at 30 deg. to 40 deg. lower for steel 1 than for steel 2. The austenitic steel 3 showed only a small reduction of impact value down to −180 deg. Cent. In steels 4 and 5 (Fig. 2) the impact value falls with falling temperature; in both cases the transition temperature for the tough condition (T) was about 150 deg. lower than for the temper-brittle condition (B). In spite of similarity of chemical composition the transition temperature for steel 4 was about 120 deg. lower than that for Steel 5. Steel 6 was tested only at room temperature. Tensile tests at room temperature on smooth specimens gave the results shown in Table I. The two treatments of steels 4–6 gave closely similar yield, tensile strength and elongation. A difference shown by the lower breaking stress in the temper-brittle condition, occurred at the last stage of the test when a tri-axial condition of stress was set up in the reduced area. With increased diameter of test piece, from 6mm to 26mm, the yield and tensile strength were practically unchanged while reduction of area, elongation and breaking stress diminished (Fig. 3). The decline was about the same for both conditions of heat-treatment, but the reduction of area and especially the breaking stress were lower for the temper-brittle than for the tough condition. With increasing size of test piece there was an increased tendency to granular fracture which was more evident in the temper-brittle than in the tough material. The largest specimen of steel 5 in the temper-brittle condition fractured into four pieces by two transverse fractures at the ends of the region of local constriction joined by a longitudinal break.

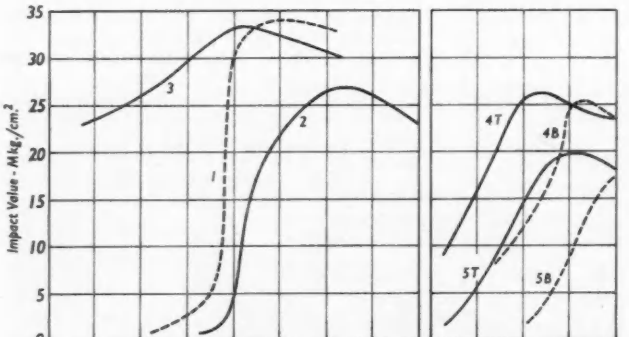
* "Behaviour During Deformation Under Multi-axial Stresses of Steels having Different Notch Impact Toughness," *Archiv für das Eisenhüttenwesen*, July/August, 1953, page 315.

TABLE II—*Tensile Tests on Unnotched Specimens of Nickel-Chromium Steel 5 (Table I)*

Condition	Temperature of test, deg. Cent.	Yield strength, kg/mm²	Tensile strength, kg/mm²	Elongation (l = 5d), per cent	Reduction of area, per cent
Tough	+ 20	72	84	21·2	60
Brittle	+ 20	72	83	21·2	57
Tough	− 75	78	90·4	20·6	59
Brittle	− 75	76	88·9	20·6	57
Tough	−180	109	112·9	16·4	55
Brittle	−180	106	107·3	2·6	3

TABLE I—*Chemical Composition, Heat-Treatment and Mechanical Properties (Longitudinal) of Experimental Steels*

Steel No.	Type of steel	Composition, per cent C	Si	Mn	Cr	Ni	P	S	Diameter of bar, mm	Heat-treatment, deg. Cent.	Impact value, mkg/cm² Charpy	DVM	Lower yield, kg/mm²	Tensile strength, kg/mm²	Elongation, per cent	Reduction of area, per cent	Breaking stress, kg/mm²
1	Non-ageing	0·12	0·10	0·43	—	—	—	—	60	930 deg./air	≧33	—	26	38	44	72	90
2	Basic Bessemer	0·13	0·23	0·60	—	—	0·069	0·029	60	930 deg./air	15	—	30	48	37	64	93
3	18/8 Cr-Ni	0·10	0·67	0·40	18·0	8·9	—	—	60	1080 deg./water	≧33	—	30	62	62	67	147
4 T	Ni-Cr	0·31	0·26	0·56	0·86	3·4	0·022	0·029	60	900 deg./oil, 650 deg./water	26	—	70	84	23·1	69	166
4 B	Ni-Cr								60	900 deg./oil, 650 deg./furnace	13	—	69	84	23·4	67	154
5 T	Ni-Cr	0·25	0·23	0·53	0·90	3·5	0·035	0·029	35	820 deg./oil, 620 deg./water	16·5	12·5	71·5	84	22·1	63	145
5 B	Ni-Cr								35	820 deg./oil, 620 deg./furnace	2·2	3·0	69·5	82	22·1	60	139
6 T	Cr-Mn-Si	0·38	0·56	1·08	1·10	—	0·028	0·026	120	850 deg./oil, 630 deg./water	—	11·5	72	89	20·3	63·5	—
6 B	Cr-Mn-Si								120	850 deg./oil, 630 deg./furnace	—	3·8	71·5	87	19·3	60·5	—



Figs. 1 and 2—Impact Value/Temperature Curves Steels 1 to 5 in Table I

Low-Temperature Tensile Tests

The difference between the tough and temper-brittle condition was shown more clearly when the testing conditions were made more severe by lowering the testing temperature. As an example, data are given in Table II of tensile tests on unnotched specimens of steel 5 at temperatures from +20 deg. to −180 deg. Cent. Whereas for the tough condition good elongation and reduction of area are shown even at −180 deg. Cent., these have fallen to very low values for the temper-brittle condition. The appearance of the fractures was also noteworthy. Test pieces in the temper-brittle condition had granular fractures at all temperatures, even when they showed good elongation and reduction of area. In the tough condition a granular fracture was found at −180 deg. Cent. in spite of a good, almost unaltered reduction of area. The change in appearance of fracture can thus occur without any marked fall in elongation and reduction of area.

Notched Tensile Tests

It is known that the notched tensile test, in which a multi-axial state of stress is present, responds to alterations in testing conditions, such as form of notch, temperature and rate of deformation as well as to previous heat-treatment of the steel, in a similar way to the impact test. From steels 4 and 5, test pieces of diameter 23mm were prepared with a circumferential sharp notch. The ratio of diameter d at the root of the notch to the specimen diameter D was varied within wide limits by alteration of d. Results of tests carried out at room temperature are shown for steel 5 in Fig. 4. The tough specimens, from the material water cooled from the tempering temperature, always gave higher tensile strength, reduction of area and breaking stress than the temper-brittle specimens. With diminishing values of $(d/D)^2$, i.e. with increasing depth of notch, the tensile and breaking strength increased, while the reduction of area at first fell steeply, more so for the brittle than for the tough material, and then more slowly. The brittle specimens had a granular fracture. The tough specimens, on the other hand, first began to show a partially granular fracture when $(d/D)^2$ fell below 0·8, where the change of appearance was not associated with any discontinuity of properties.

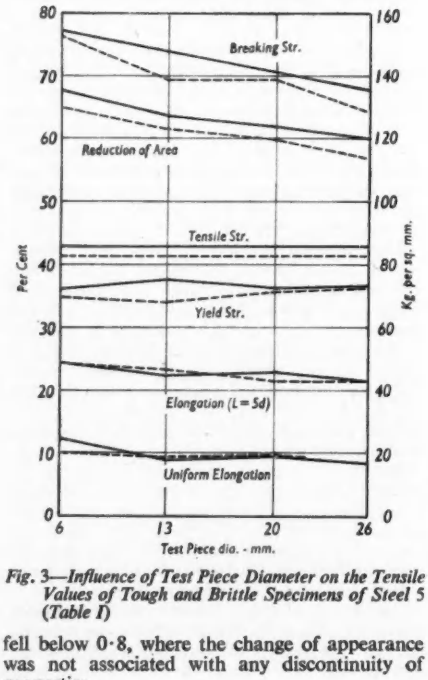


Fig. 3—Influence of Test Piece Diameter on the Tensile Values of Tough and Brittle Specimens of Steel 5 (Table I)

Bend Tests

Multi-axial stresses also occur in bend tests. If a relatively broad flat bar is bent, the transverse curvature which should occur at the bend is hindered by the loading plunger, giving rise to

transverse stresses which may amount to 30 per cent of the longitudinal stress. Specimens of steel 5 in both conditions, 12mm by 34mm in cross section, were bent statically at different temperatures. At room temperature and at −75 deg. Cent. test pieces of both heat-treatment conditions could be bent without cracking to 90 deg. At −180 deg. Cent. only the tough specimen reached a bending angle of 90 deg., while the temper-brittle specimen broke with a brittle fracture at a bending angle of 0 deg. Bend specimens which had been notched on both sides were also tested. The following table gives the angle of bend at fracture and the appearance of the fractured surface (F=fibrous, G=granular) :—

Temperature of test, deg. Cent.	Tough condition, deg.	Temper-Brittle condition, deg.
+ 20...	32 F...	16 G
− 75...	32 F...	12 G
−180...	4 G...	0 G

Experiments on Tubes under Internal Pressure

In a tube closed at the end a tri-axial state of stress is produced by internal pressure. To attain different ratios of tangential to longitudinal stress the tube specimens were made so that an additional longitudinal tension could be applied. Internal pressure and longitudinal tension were raised by stages in constant proportion with one another until fracture occurred. The test was carried out on tubes of steels 1–4 (Table I) with outer diameter 45mm, inner diameter 36mm, wall thickness 4·5mm. Ratios of tangential to longitudinal stress were nil (longitudinal tension without internal pressure), 0·66, 0·8, 1·0 and 2·24 (internal pressure without additional longitudinal tension), the

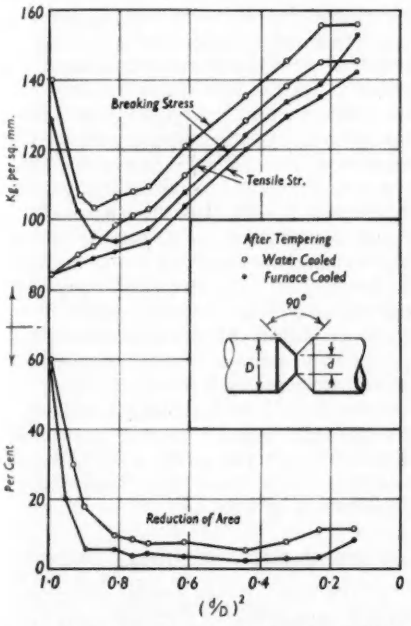


Fig. 4—Notched Tensile Tests on Tough and Brittle Specimens of Steel 5 (Table I)

stresses being calculated on the initial cross section of the specimen. With a ratio of tangential to longitudinal stress of 0 or 0·66 (longitudinal stress strongly predominant) all fractures were transverse. When the ratio was 0·8 the fractures were more varied. Steels 1 and 4 (T) showed purely transverse fractures, steel 3 a longitudinal crack only, steels 2 and 4 (B) transverse fractures with longitudinal cracks. When the ratio was from 1·0 up to 2·24 (i.e. under internal pressure only) the fractures were all longitudinal, but in the more brittle steels 2 and 4 (B) the longitudinal fracture was extended at the ends into transverse cracks. In the transversely broken specimens the longitudinal stress at fracture was, for all four steels, about equal to their tensile strength.

Tough and temper-brittle specimens of steel 5, of equal hardness, were tested similarly at ratios of tangential to longitudinal stress of 0·9 and 1·1. Here, again, specimens of the two conditions differed clearly only in the form of the fracture: whereas the tough specimen showed only a longitudinal crack, the brittle specimen broke into four or five pieces. This was in agreement with the markedly inferior impact properties of steel 5 compared with steel 4, shown by its lower impact value at room temperature and its higher transition temperature (Fig. 2).

In order to study the influence of wall thickness in the tube experiments, specimens with a 60mm bore, 80mm, 90mm and 100mm outside diameter and 400mm long, were prepared from a 120mm diameter bar of steel 5. Internal pressure (without additional tension) was applied in stages and the outside diameter of the specimen measured at each stage. Owing to the risk of bursting, measurements were made at reduced loads and corrected for the elastic expansion before being shown graphically (Fig. 5). The

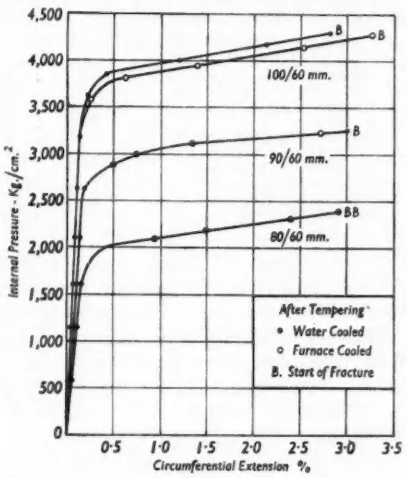


Fig. 5—Internal Pressure Tests on Tubes of Different Wall Thickness in Both Conditions of Steel 5 (Table I)

influence of notched-bar impact figure is not to be seen in the pressure/extension curves, but was clearly evident in the type of fracture. With all wall thicknesses longitudinal cracks only appeared in specimens in the tough condition. In marked contrast to this, temper-brittle specimens were shattered into many pieces, and the number of broken pieces clearly increased with the wall thickness of the specimen. The effect of wall thickness appeared also in specimens of the tough condition in so far as the thick-walled tubes showed not only one but two longitudinal cracks. The tough specimens showed, at least at the initial break, a sliding fracture, but the fractures of the fragments of the temper-brittle specimens were entirely granular.

Similar experiments were made on steel 6 in the form of specimens with a 60mm bore and outside diameters of 72mm to 100mm, the wall thickness thus varying from 6mm to 20mm. The difference in the type and appearance of the fractures in the tough and temper-brittle conditions were the same as were observed in steel 5; but whereas in the nickel-chromium steel 5 the circumferential extension and the internal pressure at the commencement of fracture were almost the same for both states of heat-treatment, in the chromium-manganese-silicon steel 6 these values differ for the two conditions. For the temper-brittle specimens the calculated stress at fracture was only about as high as the yield point in the tensile test, whilst for the tough condition the values were about equal to the tensile strength (Fig. 6). In steel 6 the circumferential extension at fracture was 0·1 to 2·5 per cent for the temper-brittle state as against 4·6 to 10 per cent for the tough condition. The difference in behaviour of steels 5 and 6 is not explained, but the authors suggest that the chromium-manganese-silicon steel is probably inherently a more brittle steel than the nickel-chromium, and that this might be shown by an impact value/temperature curve not only in a higher transition temperature, but also maximum impact value attained. Unfortunately, the experiments on steel 6, which were carried out in another laboratory, could not be completed by determinations of impact values over a range of temperature.

Alternating and Repeated Impact Tests

Experiments were made to ascertain whether the differences in impact value were reflected in the results of alternating stress tests. Wöhler tests on unnotched and notched specimens of steel 5 gave equally high fatigue strength and similar notch sensitivity for both conditions of heat-treatment. The final fracture took place over a larger area in the temper-brittle specimen than in the tough; a crack of smaller depth leads to a break through in the less tough material. A corresponding result was obtained in the Krupp repeated impact machine with rotation of the specimen through 180 deg. after each blow. When the energy of impact was high, the tough specimen endured a much greater number of blows than the temper-brittle specimen. With decreasing impact energy and a correspondingly increased number of blows, this difference becomes less. The beginning of a crack occurred after about an equal number of blows for both the tough and the brittle specimen. The number of further blows required to complete the fracture was, however, greater for the tough specimen, and the area of the final fracture was considerably smaller, than for the brittle specimen.

The influence of impact value on behaviour in fatigue is thus confined to what happens between initial formation of a crack and the final fracture. The true fatigue strength was not influenced by the impact value of the material in the notched-bar impact test.

Conclusions

In summing up, the authors conclude that any tendency to brittle fracture which finds expression in the notched-bar impact value also reveals itself in other circumstances as soon as a state

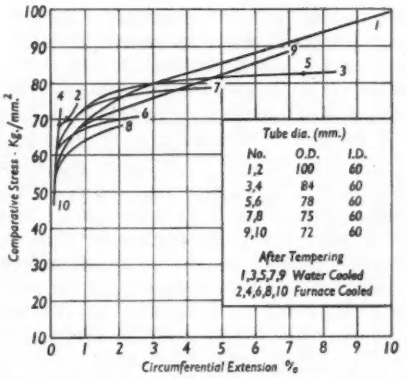


Fig. 6—Internal Pressure Tests on Tubes of Steel 6 in Both Conditions (Table I)

of multi-axial stress arises. A bi-axial state of stress is sufficient to influence the transition from tough to brittle fracture. The mode of fracture of cylinders under internal pressure, whether by extension of a longitudinal crack or by shattering into many pieces, is governed by the degree of brittleness revealed in notched-bar impact tests, though this may not affect the pressure/expansion relation until the initial crack is formed. With an extreme degree of brittleness, however, and a high transition temperature in the impact value/temperature curve, brittle fracture of a cylinder may occur with decreased deformation and at a correspondingly lower breaking strength than is shown by material of good notched-bar impact value. Thus, a tendency to brittle fracture revealed in the notched-bar impact test is not limited to the state of stress obtaining in that test, but extends to a wide range of service conditions involving multi-axial stress. In all such circumstances, a uniformity may be noted in the effect of intensifying stress conditions, lowering of temperature or increasing the rate of straining, all of which increase the tendency to brittle fracture. These variations have the same effect on the notched-bar impact test, which may accordingly be regarded as indicating an intrinsic property of the material.

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TECHNICAL DISCUSSIONS OF ROCKET PROBLEMS

Except for certain aeronautical work the development of rockets lies almost wholly under Government direction. That situation, as a contributor to this issue, Mr. Eric Burgess, points out, is unfortunate. For, in view of its military significance, a veil of secrecy has been thrown over the work and only those actively concerned know how far it has gone. The veil, indeed, is so heavy that few engineers, we believe, appreciate what are the potentialities of rockets. All of them, no doubt—more especially those blessed with children—have enjoyed reading phantasies about space ships, the exploration of the moon and fights with monstrous Martians in interplanetary space. Yet, being practical men they have regarded them as dreams much more visionary than the stories by Jules Verne that so entertained our fathers. So, at least for our generation and probably many to come, they are visionary and fantastic. But it is, nevertheless, a mistake to leap from that wholly justifiable conclusion so far as to suppose that there are not realizable, much sooner, practical results of rocket development that are not earthbound. The secrecy that surrounds rocket development for military purposes hides from practical down-to-earth engineers that the project of setting up an artificial satellite of the earth is a practicable and sensible object of rocket research, one that ought to be actively pursued and one that many scientists would like to see actively pursued on account of the valuable knowledge that might accrue.

Burgess calls the construction and setting up of an artificial satellite "a fascinating technical problem of the first magnitude," but one "which engineers of to-day are capable of solving." He is, perhaps, optimistic. For as he is himself an astronomer and not a qualified engineer it is possible that he does not fully appreciate the complexity of the technical problems involved. Yet sufficient information has already been published to indicate the probability, even with present propellants, that the project is practicable even though difficult problems remain to be solved; that, in fact, it is no more than a difficult engineering problem likely to yield a solution to normal engineering methods of research, development, trial and improvement. It is, furthermore, a project promising much more of positive value to the human race than the further development of rocket weapons. But unfortunately the primary purpose of those concerned with rocket research is military. The setting up of an artificial satellite, however desirable for scientific reasons, cannot be more than a secondary consideration in military thought. The prime purpose of military research is to develop rocket weapons. Nor aeronautically is the situation any better. For aeronautical research, valuable as the application of rockets may prove, is earthbound, too. Moreover, to some of that work, as to high-altitude rocket research, military secrecy applies. The concentration upon the military aspects of rocket research and the consequent secrecy that conceals so many of its results seems to us as deplorable as it seems to our contributor. For we agree with him that competition between the nations to set up artificial satellites would be nonsensical and dangerous. In the mind of our contributor there is only one escape, however, from military direction. It lies in the setting up of an international body which would undertake rocket research and undertake it, apparently, in defiance of governments and their military advisers. We confess that we find the idea about as visionary at the present day as interplanetary flight! For governments, under the sway of military advice, are hardly likely to permit an international body, even were it practicable to get one going, to tear in shreds the veils of secrecy that cover up so much of the work at present being done on rockets.

There is another way. If bodies other than government establishments showed more interest in the subject, gave facilities for its open discussion and encouraged researches in it directed to non-military ends, they would acquire the influence to convince governments of the need to release more information and of the value of concentrating more research upon projects other than military ones. Instead, therefore, of attempting at once to set up some international body we feel that it would be far more practical at present to provide facilities for engineers in each country concerned with rocket development to associate together and to discuss their common problems in so far as secrecy regulations permit. We feel also that the fostering body in each country should be one not in itself associated with any particular side of the subject. It should not be especially concerned to promote interplanetary flight, nor should its interests be primarily military or aeronautical. It should be indiscriminately interested in all technical aspects of rocketry and able, therefore, to provide a forum at which all working in that field or merely interested in it could meet and discuss it. For the bulk of technical problems involved, whether military, aeronautical or in setting up an artificial satellite are common to rocketry in general; only some apply solely to particular fields. We can think of no body in this country more appropriately situated to foster such an association and to ensure that its discussions remained upon a practical down-to-earth engineering plane than the Institution of Mechanical Engineers. Nor do we think, even under the existing conditions of secrecy, that subjects for discussion would be lacking, down-to-earth technical subjects having nothing visionary or purely academic about them. The military mind, which sees clearly how unanswerable are the arguments for keeping operational details as secret as possible from an enemy, finds difficulty in comprehending the undesirability of concealing technical developments. It fails to appreciate, in the single-mindedness of its military thought, that technical developments almost invariably have immediate values for other than military purposes that far outweigh the transient advantage of concealment from prospective enemies. Open discussion of rocket problems by a Rocket Group at the "Mechanicals," limited though it might be by security regulations, might well help to convince the Government, even if not its military advisers, of the desirability of permitting a freer flow of information.

DISTINGUISHED RAILWAY FAMILY

In the days of the smaller independent railway companies of Great Britain, before grouping took place in 1923, it was the custom for ambitious men to move from one line to another in search of promotion. Many examples come to mind, but perhaps the most remarkable is that of Dugald Drummond, who served successively on the Highland, the Brighton, the North British, the Caledonian, and on the London and South Western. On the last three of these lines he was locomotive superintendent. With many of the smaller companies of pre-grouping days the engineering departments were scarcely large enough to provide training grounds for men of the calibre needed for chief mechanical engineers, and when the time came for a change the post often went to an outsider. On the other hand, the larger railways, like the London and North Western, and the Great Western could not only provide eminent men to fill

the highest executive positions in their engineering departments but the ramifications of those companies' systems were such as to afford ample scope for a distinguished career to engineers ranking somewhat below the highest levels. The Great Western in particular was served by many families to the third generation, and at a time like the present when so many of the older railway traditions are dying out it is just as well to be reminded of those loyalties and affections which stood the companies in such admirable stead for so long. For, once lost, traditions of that kind can never be recovered. The Great Western case is epitomised in the Armstrong family, whose service extended from 1847 to 1946, and railway history is immeasurably the richer now that Mr. H. Holcroft has told the full story of that remarkable association in his new book, *The Armstrongs of the Great Western*. Joseph Armstrong, the eldest of the clan to serve the company, is generally known merely as one of the two locomotive superintendents that held office between the spectacular regimes of Gooch, on the one hand, and Churchward on the other ; it is only after reading an account such as that which Mr. Holcroft has written that one realises the stature of Joseph Armstrong and the magnitude of the contribution his family made towards the maintenance of Great Western traditions. Besides himself, a younger brother, two sons, and a grandson rendered lengthy service in the locomotive department.

The Armstrongs came from a sturdy race living in the western marches of the Scottish border, between Carlisle and the Cheviot Hills ; but amid the distress, poverty and mass unemployment that followed the end of the Napoleonic wars Joseph Armstrong's father sold up and emigrated to Canada, as George Stephenson had wished to do some years earlier. But this particular family of the Armstrongs returned to England in 1824 and made their home at Newburn-on-Tyne. That name will at once be significant to Great Western men of an older generation, for when Joseph Armstrong was appointed locomotive, carriage and wagon superintendent in 1864, the company built a large house for him and his family beside the main line at Swindon. It was named " Newburn," and became thereafter the official residence of the chief mechanical engineer. Moreover, the old tradition persists to this very day, though not at Swindon. When Sir William Stanier left the G.W.R. to become chief mechanical engineer of the London, Midland and Scottish Railway and went to live near London, he, too, named his new home " Newburn." As the company provided for Joseph Armstrong so he devoted himself to an indefatigable life of service, in which he had no other interest than that of the G.W.R., and in particular the welfare of the great and rising railway population of Swindon. Joseph Armstrong had six sons and three daughters and of these four sons served their time in Swindon works. At the same period Armstrong's younger brother, George, had succeeded him as divisional locomotive carriage and wagon superintendent at Wolverhampton, and remained there for no less than thirty-three years. One son, Joseph Armstrong the younger, " Young Joe," as he was popularly known, seemed well set for a railway career even more brilliant than that of his father, and during his time as an assistant to William Dean he developed the improved version of the vacuum brake, using a cross-head pump and a considerably higher degree of vacuum than could be economically maintained with an ejector. In consequence of this, and in combination later with the direct-admission valve developed under Churchward, the Great Western express trains of pre-grouping days were probably the best braked of any in the country. Churchward himself assisted " Young Joe " in this early work on the vacuum brake, and apart from his success in this development Armstrong showed such exceptional inventiveness and talent that he was generally considered the most likely successor to William Dean. But " Young Joe " met with a tragic end. He was killed on the line at Wolverhampton on New Year's Day, 1888, at the early age of thirty-one. Many years later, when his nephew was at Newburn, Churchward said : " If your Uncle Joe had lived, I should not be occupying this house to-day as locomotive superintendent : he was a far cleverer man than I." That nephew was Ralph Joseph, son of John Armstrong, and this father and son—of the second and third generation of the family—each served the Great Western for exactly fifty years.

Such, in the merest outline, is something of the fascinating saga Mr. Holcroft tells in his book, *The Armstrongs of the Great Western*. It covers the period right down to 1946, almost to the time when the railway itself lost its separate identity under nationalisation, and when the historic organisation of the chief mechanical engineer's department was broken up and divided into three separate sections. Under the old regime the divisional superintendents at centres like Neath, Newton Abbot, Worcester and Wolverhampton, not to mention the London Division, were the local representatives of the C.M.E. in all matters—locomotives, carriages, wagons, outdoor machinery and locomotive running ; they controlled the footplate staff. Three of the Armstrong family held these distinguished positions. The case of George, at Wolverhampton from 1864 to 1897, has already been mentioned : John had the London Division from 1882 to 1916, while his son, Ralph Joseph, was divisional superintendent at Bristol from 1919 to 1929, and afterwards in charge of the still larger division based on Worcester till his retirement in 1946. In reading the accounts of their several careers one cannot fail to be struck by their devotion to the company, by their interest in local affairs, particularly where they affected the lives and welfare of Great Western employees, no less than their conspicuous ability in discharging the immediate tasks of their high office. It is, however, very important to emphasise that the tradition of family service to the railway was never confined to those in high executive positions. In many districts of the West Country service to the Great Western was the recognised and cherished family calling in countless modest homes, and this tradition applied to other parts of England prior to the grouping of the railways. Centralisation and departmentalism tend slowly, but inexorably, to kill the keen district and divisional loyalties of old, and Mr. Holcroft's vivid account of the divisional careers of George, John and R. J. Armstrong, and, above all, that of the great Joseph, in his chieftainship at Swindon, comes as a keen reminder of a solidarity of railway outlook that is in danger of slipping away.

Literature

West Coast Steamers. By C. L. D. Duckworth, B.Sc., M.I.C.E., A.M.I.N.A., and G. E. Langmuir, M.A., LL.B. Prescot : T. Stephenson and Sons, Ltd. Price 25s.

On first glancing through *West Coast Steamers* the reader would naturally expect considerable space to be devoted to the large cross-channel steamers operating from ports on the West Coast to Ireland and the Isle of Man, yet while the steamers to the latter are adequately dealt with, this is not the case with the others. The reason, however, is simple in that the work before us is intended to be taken as an addition to former books by the same authors, and in *Railway and Other Steamers** the Irish railway steamers find an appropriate place. But even so it is felt that at the risk of duplication more attention might have been paid to the bid made by the Furness Railway to develop excursion traffic in the Barrow district with such large steamers as " Lady Moyra," while " Wyvern," a steamer plying between Heysham and Fleetwood for the Midland Railway, and then the London, Midland and Scottish Railway, might also have been included.

Perhaps the most valuable part of an interesting book will be found in the exhaustive way in which the histories of the fleets of the Isle of Man Steam Packet Company, the Mersey Ferries, and P. and A. Campbell have been traced, undoubtedly necessitating much careful research and incorporating a mass of useful information. Each of the foregoing companies has a chapter exclusively devoted to itself, while another is concerned with the Liverpool and North Wales Steamship Company, and a fifth to miscellaneous fleets, comprising a number of ventures, some of which were very short lived. This chapter is very enlightening in that it would seem to indicate how difficult it is to initiate and maintain new services in some districts. It might have been assumed that a popular resort like Blackpool would have had no difficulty in maintaining a fleet of modern steamers, but when various attempts to provide such facilities are examined by the authors it is found that many attempts have proved unsuccessful. We should have welcomed further information as to Blackpool's position. The competition in the Bristol Channel constitutes a story in itself and eventually left P. and A. Campbell with a monopoly. The preference of this company for the paddle steamer is very evident, as also is the adherence of the Isle of Man Company to the steam turbine. The authors boldly assert that " for the negotiation of restricted or crowded waterways the paddle is much superior to the screw, even when full power astern is available with screws," but we feel this is a very debatable point ; indeed, the masters of the large motor vessels which operate in the summer from London to Margate and Clacton definitely aver the contrary, and they are men who have had considerable experience in the past with modern paddle steamers. At the same time, there is food for reflection in the thought that if weather conditions at

* Reviewed in The Engineer, March 18, 1949.

Margate were unfavourable the paddle steamer proceeded to Ramsgate to land her passengers, whereas nowadays the motorship in similar circumstances does not venture into Ramsgate, returning to Southend without landing anyone in Thanet. The authors might have stressed the value of the paddle in shallow waterways. Some of the prophets foretell the survival of the paddle boat, but with an improved form of gas turbine as the motive power. But we must leave a controversial subject and return to our book, which concludes with comprehensive fleet lists set out in tabular form giving the principal dimensions and particulars of all the steamers. As might be expected certain blanks will be found owing to a lack of reliable information, but generally speaking details are fairly complete. Finally, there is a list of the steamers in the main fleets as at June 1, 1953.

The book is well illustrated with photographs of a number of the steamers showing the development of type and the trend of fashion. For example, we have on the same page pictures of P.S. " Britannia " in 1946, and of the same steamer two years later, an additional funnel greatly altering her appearance ; a picture of her as originally built in 1896 would complete the story. Similarly, it is instructive to compare the four different " Tynwalds " of the Isle of Man fleet that are illustrated, clearly indicating as they do the development of the cross-channel steamer.

We miss the authors' general remarks, which have been found at the end of each of their previous works, giving an insight into their personal opinions, criticisms of the companies they have so ably described, and suggestions as to possible future developments.

Undoubtedly *West Coast Steamers* is replete with valuable information, systematically presented so that it is easy to follow, and it must prove a welcome addition to the libraries of all those who are in any way interested in the many classes of vessel to be found around our coasts.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

GAS TURBINE AND DIESEL-ELECTRIC LOCOMOTIVES

SIR,—While I would agree with Mr. Harris that in ordinary working the two gas turbine locomotives 18000 and 18100 are operated at very much less than their maximum capacity, when delays have occurred the existence of that capacity in reserve has resulted in time being recovered more frequently than is usually possible with the existing steam locomotives. During the past few months I have personally experienced two remarkable cases of recovery, one with No. 18100 on the 11.15 a.m. down from Paddington, and the other with No. 18000 on the 12 noon up from Bristol. No. 18100 got a 9-min late start from Paddington and, despite one long slack for track repairs near Challow, we covered the 106·9 miles to Bath in 99¼ min, start to stop. The check cost 4 min in running, and thus the net average speed, with a load of 425 tons, was 67·4 m.p.h. On the 12 noon up, load 445 tons, the start from Bath was 17 min late ; 2½ min were regained to Chippenham, and a further 4 min to Swindon. On the final stage, leaving 9 min late, the locomotive covered 71¼ miles in the first hour's running from Swindon, and with 7¼ min left for the last 5·7 miles from Ealing Broadway into Paddington we might have been nearly, if not dead on, time. A check at Acton, however, made us 3 min late in.

On this run with No. 18000 the average speed over the 55·6 miles from Uffington to Hayes was 76·8 m.p.h., and while I would agree that such a performance is not beyond the capacity of a " Castle " class 4–6–0, it would need special care and attention by the crew to keep the locomotive steaming constantly at such a rate. On the gas turbine it needed no more than pushing the controller handle two or three notches further over than usual. The gas turbine reaches its optimum efficiency range when working at full load, as on this run ; but schedules cannot be planned for continuous full-load working. Some margin for recovery from delays must be included. From my knowledge of the East Coast and West Coast routes to the North I very much doubt if either has, at the moment, any services on which the gas turbines could be used to greater advantage. On the contrary, the original British main line diesel-electrics, Nos. 10000 and 10001 of the L.M. Region, have now been transferred to the Southern.

O. S. NOCK

Bath, October 24th.

TORRENTS OF THE EAST LYN AND WEST LYN

SIR,—Recently I have had the opportunity of seeing above Lynmouth the converging torrents, the flow from which, during flood in August, 1952, caused the destruction of part of the town.

I have read some of the contributions which have been written on the subject. The estimates of flood discharges have been based on the analysis of the recorded rainfall and also on the application to selected cross sections of the torrents, of flow formulæ more suitable to the uniform flow of water in streams other than torrents.

The water must have come down these torrents in a series of cascades. I doubt whether the formulæ used are applicable and suggest an alternative method which, so far, does not appear to have been considered, namely, the broad crested weir and the flume formula.

The application of the formula is simple and appears to have been disregarded, although there are sites where the discharge could have been computed or checked by this method. I refer to Hoaroak Water, just above Watersmeet, and to the West Lyn River at Lynbridge. There may be other sites.

The width of the flume or the weir can be measured with a tape and it would have been possible to know the height to which the water rose.

The formula applicable is $3{\cdot}1Bh^{3/2}$ and h will include besides the measured depth, an allowance for the head due to velocity of approach.

The velocity of the water is $3{\cdot}1h^{\frac{1}{2}}$. The head due to the velocity of approach is $V^2/2g$.

No coefficient is needed and the error due to the approximation taken for the velocity of approach is not serious.

It is possible to claim that the flow will not be in excess of the figure given by the application of this formula.

For a mean velocity of 10,

$$V^2/2g \text{ is } 100/64=1{\cdot}6.$$

For a mean velocity of 15,

$$V^2/2g \text{ is } 225/64=3{\cdot}5.$$

For a total depth of 10ft the velocity of the water will be 9·8.

For a total depth of 12ft the velocity of the water will be 10·7.

For a total depth of 15ft the velocity of the water will be 12·0.

We have an idea of the movement of the water and of the likely depths and velocities.

Applied to the channel of the West Lyn at Lynbridge I estimated the maximum discharge that would have passed this site to be $3{\cdot}1\times50\times12^{3/2}=155\times41{\cdot}52=6435$ cusecs against a figure given of 8630.

At the bridge on the East Lyn there is a flume upstream which is 45ft wide, but I could not determine the height to which water flowed in the East Lyn. The water mark shown on the Lyndale Hotel near the bridge must be due to the self-diverted West Lyn which, during the flood, flowed towards this hotel before joining the East Lyn below the bridge.

The engineers on the spot have not given an estimate of the effect on the damage done, of the blockage of the bridges of the West Lyn at Barbrook and at Lynmouth.

I consider that it is important, previous to each flood season, to remove from torrents which flow close to built-up areas, all fallen and falling trees and other debris likely to be washed down and to choke the available bridgeways. These bridge waterways should also have flumed approaches to increase their efficiency.

At the same time, I agree with the opinion expressed in the *Journal* of the Institution of Water Engineers for March, 1953, that it is not necessary to have an excessive discharge to account for the damage sustained. Especially when the effect of the blockage of the bridges is taken into account.

W. P. THOMPSON

Liverpool,
October 28, 1953.

Opening of Parliament

THE third session of the present Parliament was opened last Tuesday morning by Her Majesty The Queen, who was accompanied by H.R.H. The Duke of Edinburgh. In the Speech from the Throne, the Queen said that it would be the constant aim of her Ministers to strengthen the national economy and thereby to safeguard the high standards of the social services and the stability of employment. To that end they would strive for a further improvement in the balance of overseas payments by encouraging the expansion of exports and of services earning income from abroad. The Speech intimated that Bills would be introduced to amend the financial provisions of the Town and Country Planning Acts and the existing arrangements for payment of equalisation grant to local authorities in Scotland. Other legislation indicated by the Queen's Speech included proposals for the transfer of responsibility for atomic energy from the Ministry of Supply to a statutory corporation ; and legislation to revise, consolidate and extend the law on the safety, health and welfare of miners and quarrymen, and to provide benefit for certain further cases of disablement from industrial diseases. It was also stated in the Speech that Ministers were attentively examining the Road Traffic Acts with a view to introducing further legislation to improve road safety and promote the orderly use of the roads. In addition, a Bill would be introduced to reorganise electricity supply in Scotland, and the Government would lay before Parliament proposals for carrying out its policy for television development.

BOOKS RECEIVED

Principles of Electronics. By L. T. Agger. London : Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 18s.

Small Transformers and Inductors. By K. A. Macfadyen. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 37s. 6d.

Strength and Elasticity of Materials. By W. H. Brooks. London : Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, W.1. Price 15s.

The Design of Dams. By A. Bourgin. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 45s.

Introduction to Elliptic Functions. By F. Bowman. London : English Universities Press, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 12s. 6d.

The Dimensioning of Engineering Drawings. By W. Abbott. Glasgow: Blackie and Son, Ltd., 17, Stanhope Street. Price 10s. 6d.

Maximum Arc Energy During Interruption of Alternating Current*

By H. GOLDENBERG, M.Sc., A.R.C.S.†

Summary

In the following analysis the arc energy liberated during the first current loop is derived for a circuit consisting of an arc (of constant voltage characteristic), an inductance and a resistance connected in series across a sinusoidal voltage source of negligible impedance and of any given frequency. The maximum value that this arc energy can reach for varying arc voltages is obtained mathematically for any point of commencement of current flow during a half cycle of the applied voltage wave (i.e. for any current asymmetry), and for any fixed values of inductance and circuit resistance, assuming, in each case, the presence of the appropriate magnitude of arc voltage.

Curves are drawn giving the calculated values of the maximum arc energy liberated during the first current loop for all current asymmetries for the cases of zero resistance and of a ratio of resistance to inductive reactance of 0·1. It is noted, however, that arc voltage limitation prevents attainment of these maxima in certain types of circuit breaker.

The relevant results of a previous paper by Boehne[1] on this subject are obtained and extended.

Introduction

Some modern designs of arc chute and low power oil circuit breakers work on the principle that by using the resistance of the arc itself the current and voltage during the clearance of a fault are forced more nearly into phase, thereby reducing both the current amplitude and the recovery voltage at current zero. This involves the liberation of considerable amounts of energy in the breaker. It is therefore clearly desirable to know the maximum arc energy which can be released from any given circuit so as to ensure that the breaker will not run the risk of physical damage.

For the purposes of calculation of arc energy liberated during the period of time defined by a current loop there are many cases when the arc voltage may be taken as a constant for the duration of that current loop, as the arc voltage near current zero has no substantial influence on the consequent arc energy. It is of practical importance, therefore, to calculate the maximum arc energy which can be developed during the first current loop at all possible current asymmetries for a circuit in which inductance, resistance and an arc (possessing a constant voltage characteristic) are connected in series across a sinusoidal voltage source of negligible impedance.

Boehne[1] has partially solved this problem by a graphical method. The relevant results of his paper are obtained and extended in the present account by a more direct method which permits further results to be computed with comparative ease for one or more current loops.

Arc Energy Liberated During First Current Loop

A sinusoidal voltage $e \sin \omega (t+t_o)$ is applied at time $t=0$ to a circuit consisting of an inductance L and a resistance R in series with a constant arc voltage v. The current i at any subsequent time t is given by

$$L\frac{di}{dt}+Ri+v=e \sin \omega(t+t_o).$$

The solution of this linear differential equation which is zero at time $t=0$ is

$$i(t)=\frac{-v}{\alpha X}[1-\exp(-\alpha\omega t)]+\frac{e}{X(1+\alpha^2)}[\alpha \sin \omega(t+t_o) -\cos \omega(t+t_o)-(\alpha \sin \omega t_o-\cos \omega t_o)\times \exp(-\alpha\omega t)] \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where

$$X=\omega L \text{ and } \alpha=R/X.$$

Let the current i next be zero at time $t=t_z$. Then t_z is the least positive solution of

$$i(t_z)=0 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The arc energy W liberated during the first current loop is therefore

$$W=\int_0^{t_z} vi(t)dt=v\int_0^{t_z} i(t)dt$$

which, in virtue of (1), may conveniently be written as

$$\frac{\omega X}{e^2}W=\frac{-\lambda^2}{\alpha^2}[\alpha T_z-1+\exp(-\alpha T_z)]+\frac{\lambda}{1+\alpha^2}[\alpha \cos T_o +\sin T_o-\alpha \cos (T_z+T_o)-\sin (T_z+T_o)] -\frac{\lambda(\alpha \sin T_o-\cos T_o)}{\alpha(1+\alpha^2)}\{1-\exp(-\alpha T_z)\} . \quad (3)$$

where

$$\lambda=v/e,\ T_o=\omega t_o \text{ and } T_z=\omega t_z.$$

Further, as $R\to 0$ so $\alpha\to 0$ and (3) reduces to

$$\frac{\omega X}{e^2}W=\lambda \sin T_o+\lambda T_z \cos T_o-\lambda \sin (T_z+T_o)-\frac{\lambda^2}{2}T_z^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3a)$$

Assuming that the arc energy W liberated during the first current loop for a fixed point of commencement of current flow T_o on the applied sinusoidal voltage wave, and for fixed inductance and resistance, possesses a maximum for varying values of λ, the ratio of the arc voltage to the peak value of the applied voltage, then this maximum is given by (2) and (3) together with

$$dW/d\lambda=0 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The fact that a single maximum usually occurs when zero resistance is present is shown in the graphical results of Boehne.[1]

Equation (4) may be written as

$$\frac{\partial W}{\partial \lambda}+\frac{\partial W}{\partial T_z}\frac{dT_z}{d\lambda}=0 \quad . \quad . \quad . \quad . \quad (4a)$$

and, in virtue of (3), becomes

$$0=\frac{-2\lambda}{\alpha^2}[\alpha T_z-1+\exp(-\alpha T_z)]+\frac{1}{1+\alpha^2}[\alpha \cos T_o +\sin T_o-\alpha \cos (T_z+T_o)-\sin (T_z+T_o)] -\frac{1}{\alpha(1+\alpha^2)}(\alpha \sin T_o-\cos T_o)[1-\exp(-\alpha T_z)] +(\lambda X/e)i(t_z)\frac{dT_z}{d\lambda} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4b)$$

Further, as $i(t_z)=0$ from (2) and $dT_z/d\lambda$ is not in general infinite at the required maxima, the final term of (4*b*) vanishes, giving

$$0=\frac{-2\lambda}{\alpha^2}[\alpha T_z-1+\exp(-\alpha T_z)]+\frac{1}{1+\alpha^2}[\alpha \cos T_o +\sin T_o-\alpha \cos (T_z+T_o)-\sin (T_z+T_o)] -\frac{1}{\alpha(1+\alpha^2)}(\alpha \sin T_o-\cos T_o)[1-\exp(-\alpha T_z)] \quad . \quad . \quad . \quad . \quad . \quad . \quad (4c)$$

Equating the values of $\lambda(1+\alpha^2)$ obtained from (2) and (4*c*) respectively gives, after a little manipulation

$$\tan T_o=\frac{-[f\alpha-f\alpha \cos T_z-f \sin T_z+(fg/\alpha) -\alpha \sin T_z+\cos T_z-\exp(-\alpha T_z)]}{[f+\alpha f \sin T_z-f\cos T_z-fg-\alpha \cos T_z -\sin T_z+\alpha \exp(-\alpha T_z)]} =\chi(T_z, \alpha) \quad . \quad . \quad . \quad . \quad (5)$$

where

$$f\equiv\frac{\alpha}{[\alpha T_z-1+\exp(-\alpha T_z)]}\cdot\frac{[1-\exp(-\alpha T_z)]}{2}$$

and

$$g\equiv[1-\exp(-\alpha T_z)].$$

Further, λ is given by (2) in the form

$$\lambda=\frac{\alpha}{(1+\alpha^2)g}[\alpha \sin (T_z+T_o)-\cos (T_z+T_o) -(\alpha \sin T_o-\cos T_o)\times \exp(-\alpha T_z)] \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and the maximum energy, in virtue of (3) and (4*c*), is

$$W_{max}=\frac{e^2}{\omega X}\frac{\lambda^2}{\alpha^2}[\alpha T_z-1+\exp(-\alpha T_z)] \quad . \quad (7)$$

Again, as $R\to 0$ so $\alpha\to 0$ and (5), (6) and (7) reduce respectively to

$$\tan T_o=\frac{\sin T_z-T_z\cos T_z}{1-T_z \sin T_z-\cos T_z} \quad . \quad . \quad . \quad (5a)$$

$$\lambda=[\cos T_o-\cos (T_z+T_o)]/T_z \quad . \quad (6a)$$

and

$$W_{max}=\frac{e^2}{\omega X}\frac{\lambda^2 T_z^2}{2} \quad . \quad . \quad . \quad . \quad . \quad (7a)$$

Therefore for a fixed point of commencement of current flow T_o on the applied sinusoidal voltage wave, and for a fixed ratio α of resistance to inductive reactance, the maximum arc energy liberated during the first current loop occurs at a ratio λ of arc voltage to applied voltage amplitude, where λ is given by (6) and T_z, which occurs in (6), is determined from T_o by means of (5). Further, this procedure may be applied to various points of commencement of current flow, and the maximum arc energy plotted graphically against T_o, the parameter representing a particular point of commencement of current flow.

The practical difficulty in this procedure is the solution of the transcendental equation (5) for T_z given T_o. This difficulty may be averted by means of an inverse process whereby values of T_z are assumed first and T_o calculated afterwards. Then, provided that T_z is the least positive solution of (5) for a particular value of T_o, the pairs of values of T_z and T_o represent the required solutions of (5), and the corresponding values of λ are calculated directly from (6). The subsequent insertion of a corresponding pair of values of λ and T_z into (7) then gives the maximum arc energy liberated during the first current loop

Notation

The meaning of several of the symbols below may be more clearly understood by consulting Fig. 1 (*a*), which shows the applied sinusoidal voltage wave.

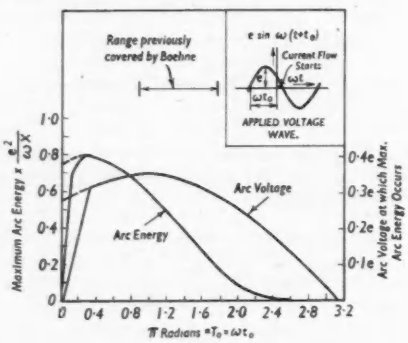
- R = Total resistance.
- L = Total inductance.
- e = Peak value of applied sinusoidal voltage wave.
- v = Constant arc voltage.
- $\lambda = v/e$.
- $\omega = 2\pi \times$ frequency of applied sinusoidal voltage wave.
- X = Total reactance $= \omega L$.
- $\alpha = R/X$.
- i = Instantaneous current in the circuit.
- W = Arc energy liberated during first current loop.
- t = Time from instant of application of voltage to the circuit.
- t_o = Interval of time between :
  - (i) Instant of application of the applied voltage to the circuit, and
  - (ii) The previous instant at which the applied voltage wave passed through zero.
- t_z = Time from the instant of application of voltage to the circuit until the current i is again zero.
- $T_o = \omega t_o$.
- $T_z = \omega t_z$.
- f, g, χ = Functions defined in the text.

* Based on Report Ref. G/T254 of the British Electrical and Allied Industries Research Association.

† British Electrical and Allied Industries Research Association, Greenford, Middlesex

for a point of commencement of current flow T_o on the applied sinusoidal voltage wave.

It is possible that the maximum arc energy liberated during the first current loop, as calculated in the above manner from an idealised circuit, does not represent a practical case, as the restriction that the voltage across the arc and the current through it must be in the same direction has not been applied. This restriction necessitates that the initial magnitude of the applied sinusoidal voltage is greater than that of the arc


Range previously covered by Boehne
e sin ω(t+t₀)
Current Flow Starts
APPLIED VOLTAGE WAVE.
Arc Voltage
Arc Energy
Maximum Arc Energy × e²/ωX
Arc Voltage at which Max. Arc Energy Occurs
π Radians = T₀ = ωt₀

Example : applied voltage 11kV at 50 c/s ; inductive reactance $0{\cdot}3\Omega$ at 50 c/s ; maximum arc energy liberated during first current loop $= 0{\cdot}8e^2/\omega X$

$$= \frac{0{\cdot}8\times(11{,}000\times\sqrt{2})^2}{2\pi\times 50\times 0{\cdot}3}\text{ watt-sec.}$$

$$= 2050\text{ kW-sec.}$$

Fig. 1—Maximum Arc Energy Liberated During First Current Loop (Zero Resistance)

voltage, and both are in the same direction. The latter direction is taken as positive in the present account.

The maximum arc energy liberated during the first current loop for any point of commencement of current flow during a half cycle of the applied sinusoidal voltage, together with the arc voltage at which this maximum arc energy occurs is given in Figs. 1 and 2 for the two cases $R=0$ and $R/X=0{\cdot}1$ respectively.

From Fig. 1 it may be seen that when zero resistance is present the overall maximum value of this arc energy for all points of commencement of current flow during a half cycle

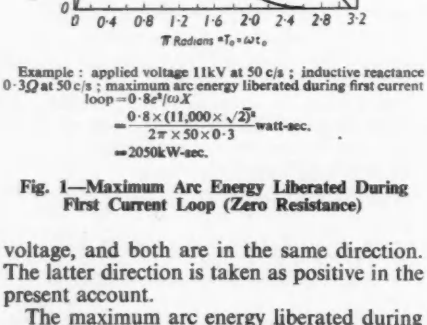


Fig. 2—Maximum Arc Energy Liberated During First Current Loop (R/X=0·1)

of the applied sinusoidal voltage is $0{\cdot}80\ e^2/\omega X$ and occurs at an arc voltage of $0{\cdot}305\ e$, while from Fig. 2 it is observed that, when the ratio of resistance to inductive reactance is 0·1, the corresponding figures for the overall maximum arc energy and the arc voltage at which it occurs are $0{\cdot}68\ e^2/\omega X$ and $0{\cdot}32\ e$ respectively.

It will be observed that a discontinuity of slope occurs in each of the two graphs. This is due to the fact that for small values of T_o the computed arc voltage at which the maximum arc energy occurs is greater than the corresponding initial applied voltage, and the latter criterion has been seen above to be inconsistent with that of an arc under practical conditions. For these small values of T_o there does not exist a true maximum arc energy liberated during the first current loop (in the mathematical sense), but only an upper limit to this arc energy. Further, this upper limit occurs when the arc voltage is equal to the initial applied voltage. At the value of T_o at which a discontinuity occurs, therefore, the arc voltage at which the "true" maximum arc energy is liberated during the first current loop is equal to the initial applied voltage (i.e. $e \sin T_o$).

The present problem has been solved graphically by Boehne[1] over the range $50\text{ deg.} \leqslant T_o \leqslant 100\text{ deg.}$ for the limited case when $R=0$. The extension of this range to 180 deg. is seen from Fig. 1 to lead to an increase of approximately 25 per cent in the maximum possible arc energy liberated during the first current loop.

Arc Energy Liberated During the Second and Subsequent Current Loops

When the arc energy liberated during the second current loop is greater than, or comparable to, the corresponding arc energy liberated during the first current loop, its calculation becomes of interest. This is especially the case for asymmetries to the right-hand end of the graph in Figs. 1 and 2 at which very little energy is liberated during the first current loop.

It may be shown from (2) that T_o and T_z satisfy the inequality

$$\pi < T_o + T_z < 2\pi,$$

and from the original definitions of T_o and T_z this is seen to mean that the current first reaches zero again during the consequent negative half cycle of the applied sinusoidal voltage wave. (The first half cycle is defined as positive.) Assuming that the arc voltage changes sign when the arc current changes sign (as is the case with a circuit breaker), the arc energy liberated during the second current loop is therefore equal to that liberated during an equivalent first current loop occurring at a different point of commencement of current flow on the applied sinusoidal voltage wave.

There is therefore a general limit imposed on the maximum arc energy liberated during each of the second and subsequent current loops, namely the same as during any possible first current loop.

Conclusions

(1) Assuming that the appropriate magnitude of arc voltage is attainable, the overall maximum arc energy liberated during the first current loop in a circuit consisting of an inductance L, a resistance R, and an arc assumed to have a constant voltage v, connected in series across a sinusoidal voltage source $e \sin(\omega t+\phi)$ is $0{\cdot}80\ e^2/\omega^2 L$. This occurs when zero resistance is present and when current flow starts at approximately 18 deg. after a zero of applied voltage. For a resistance equal in magnitude to 1/10 of the inductive reactance, this maximum possible arc energy is reduced by approximately 15 per cent.

(2) Over part of the range of asymmetry, second loops of current can give rise to energy liberation equal to or greater than in the first loop which preceded them, but although the maximum arc energy liberated during the second loop can equal, it cannot exceed the overall maximum value of arc energy liberated during the first loop.

Acknowledgment

The author wishes to express his thanks to Dr. W. B. Whitney, of the Electrical Research Association, for suggesting the present problem and for useful discussion with regard to it, and to the Director of the Electrical Research Association for permission to publish this article.

Reference

[1] Boehne, E. W.: "The Geometry of Arc Interruption," A.I.E.E. *Transactions Supplement*, June, 1941.

Thread Rolling Diehead

A THREAD rolling diehead has been introduced by Alfred Herbert, Ltd., of Coventry, for use on lathes, capstans, automatics, and drilling machines of all kinds, and one of the new dieheads is illustrated below. This diehead, known as the "Rollrite," is at present made for use on manually operated machines for rolling threads of all commercial pitches from $\frac{3}{8}$in to $\frac{1}{4}$in diameter, and this range is to be extended in due course. The diehead is of self-opening design and in it rolls formed with annular threads are carried in swinging carriers and adjusted for size by a cam-shaped housing similar to that used in the well-known Coventry diehead.

The carriers present the rolls at the correct helix angle to the work and, after the initial engagement, are self-feeding and automatically control the pitch and shape of the thread. The adjustment for size is by screw, similar to that on the Coventry diehead. A self-opening mechanism opens the rolls simultaneously at the point of tripping by pulling off the carrier supporting

Thread Rolling Diehead

body from the driving dogs on the shank. When the driving dogs are disengaged the spring-loaded carriers fly open clear of the work.

Within the range of a thread rolling diehead one set of roll carriers suits all commercial pitches of the same hand and each set of rolls for any particular pitch will roll threads of any diameter of work of the same material of either hand. Rolls are readily changed by removing the diehead front plate when the carriers can be lifted out. The rolls run on pins secured in the carriers and can be taken out and changed in a few minutes.

The leading threads of the rolls are specially shaped to facilitate the rolling action, and as the leading threads on each of a set of rolls are arranged to act in sequence, the rolls are mounted in the carriers in a special order. Each of the rolls is clearly numbered and a set is assembled in the order in a clockwise direction looking at the front of the head. In order to obtain a double life from each roll they may be reversed in the carriers. For this reason their rear faces are lettered X, Y, Z, and the rolls must be mounted clockwise in this order.

The shaping of the leading threads on each roll leaves the final thread on the component imperfectly formed. This incompletely formed thread extends for little more than one full pitch, which is less than the run-out obtained with conventional dies.

As the rolling action depends on the flow of the work material, it follows that more power is required for thread rolling than for thread cutting. The makers state that as a rough guide thread rolling takes about 50 per cent more power than would be required to cut a similar thread with a thread cutting diehead.

International Motor Show

No. III—(*Concluded from page 565, Oct. 30th*)

American and Continental Exhibits

THE United States and Canada were represented by sixteen firms, among them the bigger concerns like the General Motors Corporation, showing five models, and the Ford Motor Company three. The long post-war absence of American cars in Britain, coupled with the large number of body styles offered in each range, has resulted in some confusion in the motorist's mind as to what America is offering. An inspection of the exhibits did not substantially help to clarify matters, for without demonstration models or exploded units, it was difficult to assess their technical details. Generally speaking, there was little indication of any noticeable change in the well-known conception of the American car. There were modifications in body styles which appeared simpler, with less chromium-plating and ornamentation, and more acceptable to European taste than last year. No major alterations were apparent in the mechanical layouts which, as a rule, are characterised by high-powered engines of ample cylinder capacity, automatic transmissions, and rigid rear axles in conjunction with orthodox leaf springs.

The typical cars used by wealthy American visitors to this country and to the Continent should not lead to the erroneous idea that all American cars are luxury models. Numerically there are many more cars on the American market less roomy and powerful than the Cadillacs, Lincolns, Packards and Chrysler cars, which are simpler in finish and equipment and represent, as it were, the American conception of an "economy" car. Some of the inexpensive cars, for instance, the 2·6-litre Willy's "Overland," and the 2·2-litre "Kaiser," are normally built with a conventional three-speed gearbox which can be supplemented by an over-drive, while others, among them the popular Studebaker, Plymouth, Pontiac and Nash models, supply, at extra cost, either torque converters to supplement the orthodox gearbox or fully automatic transmissions. The engines have a cylinder capacity ranging between 2·5 litres and 4 litres and an average specific output of something between 25 b.h.p. and 30 b.h.p. per litre at the almost standard speed of 3600 r.p.m. They are, with one or two exceptions, six-cylinder engines with side valves, the only inexpensive model with a straight o.h.v. engine at the show being a 3·8-litre Chevrolet.

In contrast to these "economy" models the more expensive cars are all fitted with vee-eight engines, apart from the Packard, which still retains its 5·4-litre, straight eight-cylinder, side-valve engine. Square and over-square engines with push-rod-operated overhead valves are the rule, and the average compression ratio of the latest engines is somewhere in the region of 8 : 1. The smallest vee-eight is a 3·9-litre engine of 110 b.h.p. by Ford, and the biggest a 5·4-litre Chrysler engine, with hemispherical combustion chambers, which is said to develop 235 b.h.p. with a four-choke carburettor.

As might be expected, all large American cars are fitted with one or the other of the numerous automatic transmissions, with such names as "Hydra-Matic," "Ultra-Matic," "Powerglide," "Dynaflow," and so on. They all employ hydraulic torque converters in conjunction with three or four-speed epicyclic gears, the gear change being actuated by a hydraulic servo-system under the combined influence of road speed and engine load. Some of the latest luxury cars have weights approaching 2 tons, so that the installation of a vacuum or oil-pressure-assisted brake system becomes a necessity; for the same reason power-assisted steering is fitted, either as standard equipment or as an optional extra, to cars such as the Cadillac, Lincoln, Packard and Plymouth.

The question, whether or not American automobile design will continue to have any marked influence on British and Continental design, or vice versa, is difficult to decide. It seems likely, however, that some form of automatic transmission will have to be accepted by some of the more expensive European cars, and it is interesting to note that Rolls-Royce and Jaguar cars can already be supplied optionally with an automatic transmission. On the other hand, there are signs of an increasing influence of Continental, and particularly of Italian designers upon the body styling of American series production cars. It is also reported that American engineers are now paying more attention to fast touring and sports cars, not entirely to stem any marked invasion of the United States by British and other European sports cars, but more likely in order to keep abreast of any technical development which might become important in the future.

The French automobile industry at this year's show was again represented by the well-known firms of Citröen, Renault, Peugeot, Panhard and Levassor, and Simca. Of special interest to the British public were the small cars which, mainly for reasons of economy, have become so popular in the last five years that more than 50 per cent of all cars made in France during the current production year are of less than 850 c.c cylinder capacity. Like the majority of Continental small cars, the French exhibits were of a design which is considered unorthodox in this country, but they all combine economy with sufficient roominess and comfort, together with satisfactory road performance.

Apart from the 2-litre "Frégate," Soc. An. Renault showed several models of the very popular 750 c.c. rear-engined car. They differ in details only from those of last year, the main difference being coachwork modifications, which provide greater comfort and convenience for the passengers. The spare wheel has been moved right forward into the front compartment, thus considerably increasing the available luggage space, the heating has been redesigned to admit hot air to the rear seats, and more leg room for the rear-seat passengers has been provided.

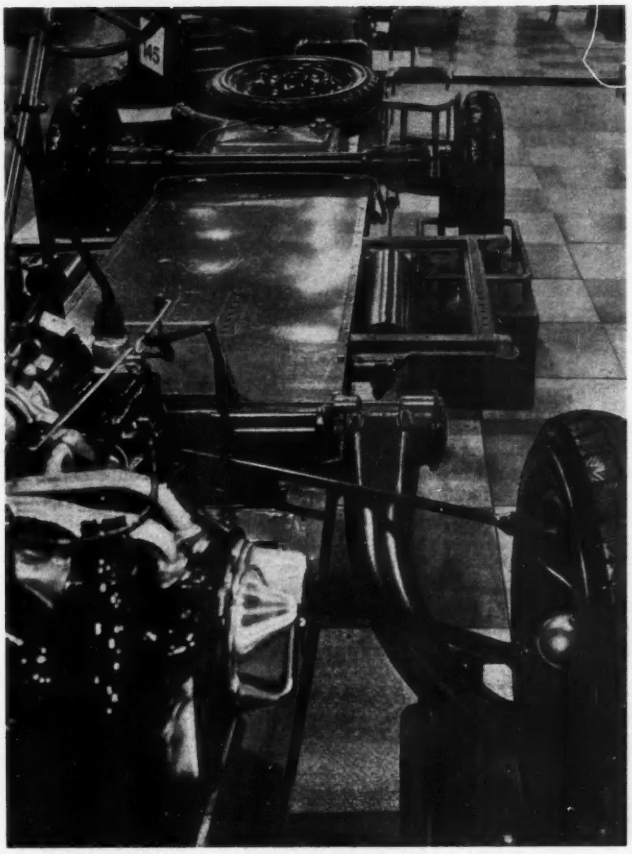


Fig. 11—Chassis and Suspension of the Citroen "2 C.V."

The sole representative at the stand of Soc. An. Panhard and Levassor was the new "Dyna 54," which, like its predecessors, has a front-wheel drive with a flat-twin air-cooled engine. The cylinder capacity of the engine has been increased from 750 c.c. to 850 c.c.; it has an 85mm bore and 75mm stroke, a compression ratio of 7·2 : 1 and develops 42 b.h.p. at 5000 r.p.m. This output, equivalent to nearly 50 b.h.p. per litre, must be considered very high for an air-cooled two-cylinder production engine. In every other respect the engine and transmission differ only in detail from that established shortly after the war, the gear-box being a four-speed synchromesh unit with an over-drive at the fourth ratio.

The previous Panhard practice of using light alloy castings for the major parts of the body chassis frame has been discontinued, the new model having a combined body-and-chassis shell of pressed aluminium sheet, built up on a strong platform-type frame of light metal and joined together by a recently developed welding technique. The roomy saloon car has a wheelbase of 8ft 5in and a track of 4ft 3in, and weighs dry only 12 cwt; it has a favourable drag coefficient and a maximum road speed of 80 m.p.h. is claimed, together with a fuel consumption of about 40 m.p.g. With a power-to-weight ratio (unladen) of 70 b.h.p. per ton, which is unusually high for European cars, the

flexibility of this vehicle ought to be excellent.

The well-known 2-litre, four-cylinder and the 2·8-litre six-cylinder front-wheel-drive cars displayed at the stand of Citröen Cars, Ltd. (the British assembly plant of the French company), have not been altered to any great extent. They retain the technical details which the Citröen company pioneered almost twenty years ago, such as chassis-less steel construction, torsion bar suspension

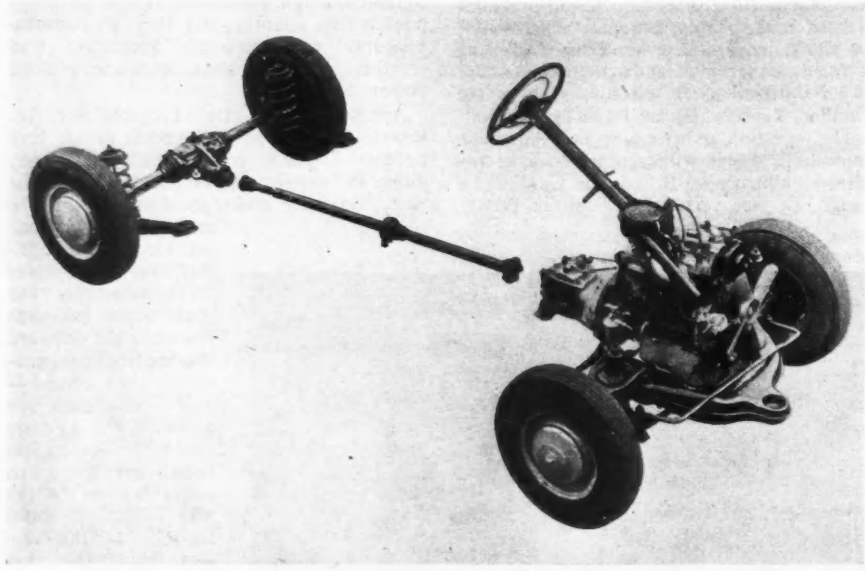


Fig. 12—Suspension, Transmission and Detachable Front Assembly of the Mercedes " 180 "

for all wheels and push-rod-operated o.h.v. engines with replaceable wet cylinder liners. The great attraction at this stand and, from a technical point of view, one of the most interesting exhibits at the show was the 2 c.v. Citröen front-wheel-drive car, fitted with an air-cooled flat-twin engine (Fig. 11). This car, though not novel on the Continent, was shown in this country for the first time. It was originally designed as an economical runabout for people living in rural areas, but is now stated to have become one of the most sought after cars in France.

In appearance the 2 c.v. Citröen is by no means impressive, as it lacks the flowing lines which are now considered indispensable in modern automobile design. It should not be overlooked, however, that the preliminary work on the project had already begun before the war and that the design was completed during the German occupation for its production with the minimum employment of press tools. The car consists of a simple frame of sheet steel to which the body is attached by means of spot welding ; the panels are flat and protected against rust by a phosphate coating. The seats are formed of light pads supported on rubber bands which are stressed across a light tubular frame. The car is fitted with a folding head, which can be rolled back, and has also a fabric cover over the spacious luggage compartment.

The 375 c.c. engine, an air-cooled flat twin, mounted ahead of the front wheels, has a bore and stroke of 62mm and develops 9 b.h.p. at 3500 r.p.m. It has push-rod-operated over head valves and well finned aluminium cylinder heads with hemispherical combustion chambers. The engine output of 9 b.h.p., which corresponds to 24 b.h.p. per litre, is low by modern standards, but this output has been kept down intentionally in order to ensure reliability and long life even when driven hard at full load over prolonged periods. The two-throw, fully-balanced crankshaft is carried in two bronze-backed white metal bearings in an aluminium crankcase, split on the centre line. Spigoted into the front end of the crankcase is the dynamo casing having no bearings, and the dynamo armature is arranged at the front end of the crankshaft. The extreme end of the crankshaft also carries the fan which supplies the cooling air to the cylinders and cylinder heads. The oil temperature is controlled by an oil cooler, mounted on top of the dynamo.

The torque is transmitted from the single-plate clutch through a drive shaft above the differential to a four-speed all-synchromesh gearbox with an over-drive at the top ratio, and it is then returned to the spiral-bevel final drive. The drive shafts to the front wheels have simple universal joints, fitted with needle bearings, constant velocity joints apparently not being considered necessary, as the small torque is transmitted at low speed.

The suspension system of this model is entirely unorthodox and unusual in its whole conception. It exhibits extraordinary steering and road-holding properties over rough country to a degree quite exceptional for a car of this size. The system is based on four bell crank levers mounted on each end of two tubular cross members, which are bolted down on top of the frame. Each crank lever has a long arm to carry one wheel and a shorter arm. The two short arms on each side are interconnected and the main suspension coil springs are incorporated, two on each side, in a floating horizontal cylinder, which is longitudinally located by volute springs (Fig. 11). When the front wheel strikes a bump the crank pivots and the short arm through its connecting-rod compresses the forward internal coil spring. This draws the cylindrical casing forward against the tension of the locating volute spring and partially compresses the rear wheel coil spring, thus bracing the rear wheel to resist the shock of the ensuing bump. The suspension arms are carried in tapered roller bearings and friction dampers are built into the pivots to deal with the low frequency oscillations of greater amplitude. Vertical oscillations of small amplitude are absorbed by inertia dampers, one of which is fitted adjacent to each wheel. The damper consists of a sealed cylindrical steel housing inside which a cast iron plunger, weighing about 8 lb and resting on a coil spring, can slide up and down. Any vertical acceleration of the wheel, produced by road irregularities, causes the plunger, which has a considerable inertia, to push the coil spring towards the bottom of the housing, thus resisting the wheel movement. A hole drilled into the centre of the mass allows air to pass from one side of the mass to the other, thus damping the oscillations. The friction dampers and these inertia dampers in conjunction with wide-rimmed wheels and large-sectioned tyres ensure that road surface irregularities can be traversed without inducing large vertical movements of the wheel.

The Citröen car should not be judged by standards applying to other cars ; it is

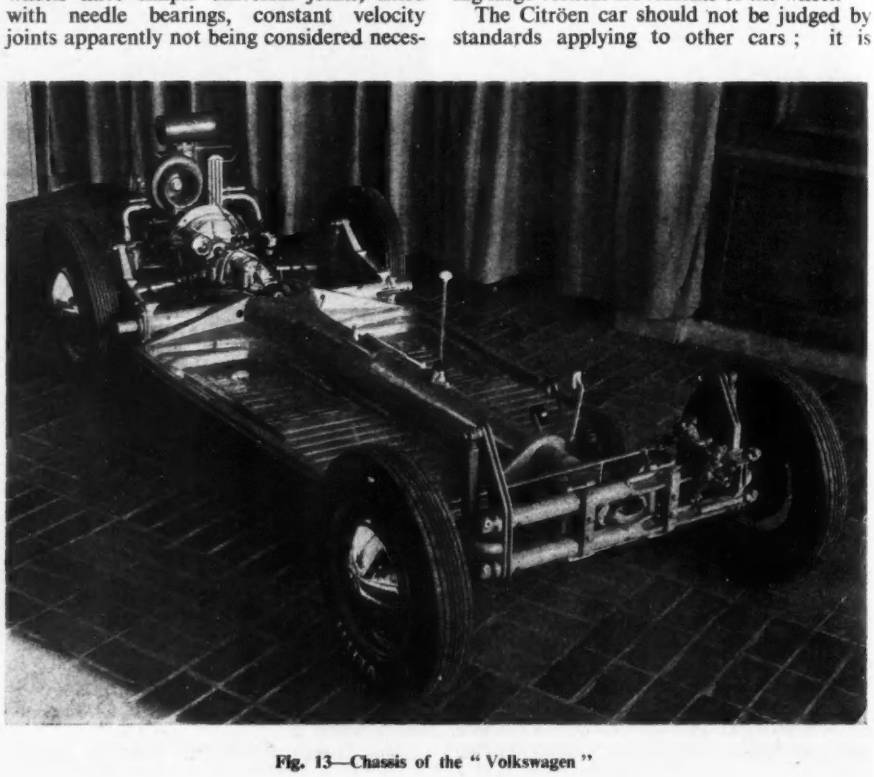


Fig. 13—Chassis of the " Volkswagen "

entirely functional in its character without laying claim to appearance and speed. It weighs only 10 cwt but, with a power-to-weight ratio of 18 b.h.p. per ton, the acceleration and flexibility necessarily remain low. The maximum speed on level ground is about 40 m.p.h. and can be sustained for as long as conditions allow without danger to the mechanism. It is claimed that a fuel consumption of about 55 to 60 m.p.g. can be obtained under ordinary driving conditions.

For the first time since the war German motor manufacturers were represented in some strength. Apart from Mercedes-Benz A.G. and Bayerische Motoren Werke, firms which used to display their latest models regularly at the pre-war London shows, two new companies, Carl C. F. Borgward and Volkswagen G.m.b.H. made their first appearance. All German exhibits, without exception, were characterised by one or another of such details as diesel engines, air-cooled engines, rear-engine drives, swing axles, all-independent wheel suspensions, &c., which are mainly considered unorthodox here. Most of the German exhibits were similar to those displayed at the Frankfurt Motor Show last spring. They were discussed in a report, published in THE ENGINEER on April 17, 1953, and only two cars, the new Mercedes type " 180 " and the " Volkswagen " are described in this survey.

Four models appeared on the Mercedes-Benz stand, among them the type " 170 SD," a diesel car of notable economy, and the type " 300 S," powered by a 3-litre, six-cylinder engine with overhead camshaft and aluminium cylinder head, developing 150 b.h.p. at 5000 r.p.m.

The latest Mercedes model, introduced only two months ago, is the type " 180," (Fig. 12), a full-width, four-five-seater saloon with a very spacious luggage locker, which represents in its appearance a rather unusual blend of modern body lines with a traditional front styling. The car deviates from the orthodox Mercedes-Benz practice inasmuch as it is built in integral construction, the main strength of the body structure being concentrated in a rigid platform, stiffened at the centre by the propeller-shaft tunnel and further by two exterior side rails. The four-cylinder engine, of 1·8 litre capacity, rather surprisingly has side valves and is basically similar to that of the older type " 170," but has an aluminium cylinder head, a compression ratio of 6·7 : 1, and develops 52 b.h.p. at 4000 r.p.m. The torque is transmitted in the usual way via a four-speed synchromesh gearbox and a divided propeller shaft to the final-drive gear, which is mounted at the rear of the body structure. The front and rear suspension units, however, have been extensively modified to prevent the transmission of gear noise and vibrations excited by road irregularities to the integral body, which, naturally, is more susceptible to resonance than the previously used construction.

The divided swing axle and the independent rear-wheel suspension by coil springs have been retained, but the final drive casing is now attached to the body by a single rubber-insulated connection. The drive as well as the torque reactions are taken by radius arms, extending forwards from the wheel hubs to rubber mountings located at the body platform. The front suspension, consisting of prefabricated pressed steel wishbones of uneven length, coil springs, concentric telescopic dampers and an anti-roll torsion bar, though remaining basically unaltered, is now attached to the body structure in a novel way. The suspension assembly, together with the steering linkage and with the steering-box itself, is mounted on a strong " U "-shaped subframe which also carries the front support of the engine gearbox unit. It is insulated from the body by three metal-bonded rubber cushions and can be removed after loosening three main bolts and disconnecting the steering column coupling as well as some electrical, hydraulic and control joints. The manufacturers claim that this arrangement, apart from facilitating repair work and assembly, greatly improves the road holding and springing characteristics of the car. It seems probable that the comparatively heavy mass of the engine on its resilient mountings, flexibly supported between the rubber cushions of the subframe and the suspension springs, acts as an inertia damper, thereby reducing the vertical oscillations resulting from road irregularities.

The Mercedes type " 180 " weighs dry 21·5 cwt (275 lb less than the older type " 170 ") and has a maximum road speed of the order of 80 m.p.h., with an average fuel consumption at 30 m.p.h. of 32 m.p.g.

The " Volkswagen," originally designed in 1935 and intended to be a State-produced " People's Car," was not made in any appreciable quantities until 1947. The present production rate is about 700 per day, and it has become not only the most popular car on the Continent, but probably one which has been more widely discussed than any other contemporary car. The main characteristics of the " Volkswagen "—its air-cooled, flat-four, 1·13-litre engine, mounted at the rear of the car, the rear drive and the all-independent suspension by transverse torsion bars—are well known and need not be described (Figs. 13 and 14). No major alterations in the basic layout have been made since the first marketing of the " Volkswagen " apart from the introduction last year of an improved gearbox for export models, having synchromesh for the upper three gears. The usual detail modifications which are part of the routine in all automobile factories, however, have resulted in improved springing, better controlled heating and more effective sound damping. The lightly stressed engine of 75mm bore and 64mm stroke, which develops 25 b.h.p. at the unusually low speed of 3300 r.p.m., has also been improved with regard to better economy and wear resistance by incorporating a thermostatically controlled throttle annulus at the air intake of the cooling fan. It is interesting to note how well this light and very compact power unit fits into the small space available at the rear of the car, without impeding the accessibility.

The " Volkswagen " weighs dry slightly less than 15 cwt, and has a maximum road speed of 65 m.p.h. with a fuel consumption (at 30 m.p.h.) of about 38 m.p.g. The power-to-weight ratio of 33 b.h.p. per ton might not appear to be very impressive, but the engine has a good torque characteristic at low speed and the road performance of the car is generally considered quite satisfactory.

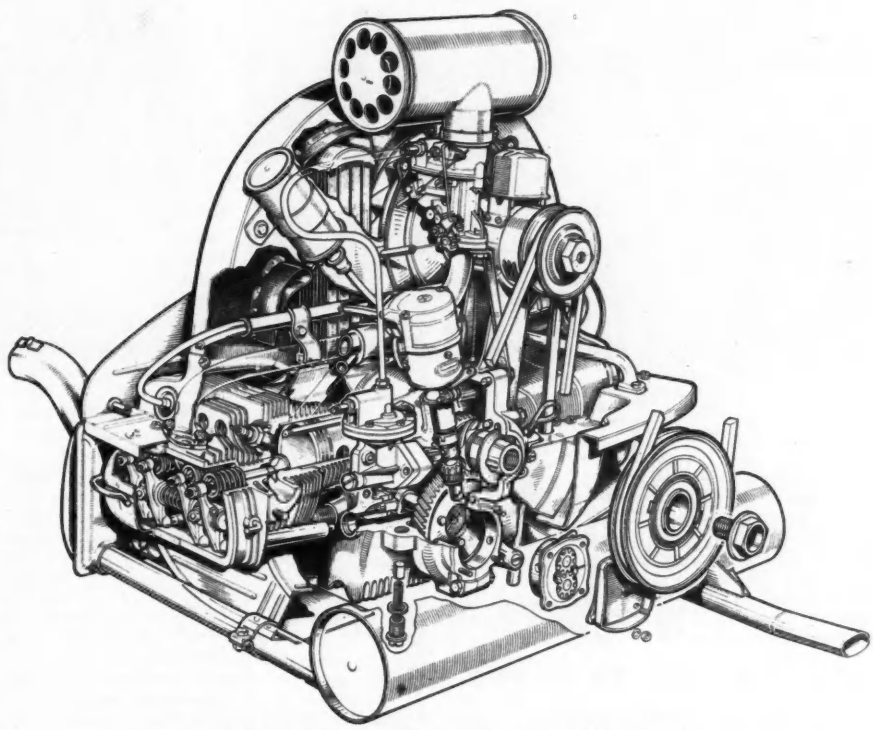


Fig. 14—Air-Cooled Flat-Four Engine of the "Volkswagen"

The " Volkswagen " is one of the rare cases in the history of automobile engineering where a motor-car owes its success not so much to the tradition and the accumulated knowledge and experience of an old-established factory, engaged in this particular field of engineering for a very long time, but mainly to bold, unorthodox layout and clever detail design.

The Italian automobile industry is represented by Alfa Romeo, Fiat and Lancia models. As usual, the design and workmanship of the Italian cars is of the highest order, and not only the body styling but also the form and shape of the mechanical layout has sometimes an almost ornamental functional beauty which is delightful to the eye of an engineer.

Three new models, not previously seen in this country, were displayed at the stand of Fiat (England), Ltd., among them a four-five-seater saloon of the type " 1400," fitted with a 1·9-litre diesel engine of the same dimensions (82mm bore and 90mm stroke) as the petrol engine of the bigger

"1900" car. Like the diesel engines of Mercedes-Benz and Borgward, the Fiat engine also employs the precombustion chamber principle, and an injection pump with a pneumatic governor; it deviates, however, in as far as it is fitted with detachable cylinder liners.

Further additions to the Fiat range were the "New 1100," a four-seater saloon, made its first appearance in this country. Like all other models built by Lancia during the past thirty years, it has a chassisless construction, the typical Lancia front suspension by coil springs and hydraulic dampers incorporated in long vertical sliding units, and the narrow vee layout of the four-cylinder engine. In many respects the car is a scaled-down version of the 1·75-litre "Aurelia," but instead of the all-independent suspension and the combined gearbox and differential unit mounted at the rear, the "Appia" employs a conventional transmission layout with the engine gearbox unit at the front and a rigid rear axle in conjunction with semi-elliptic springs.

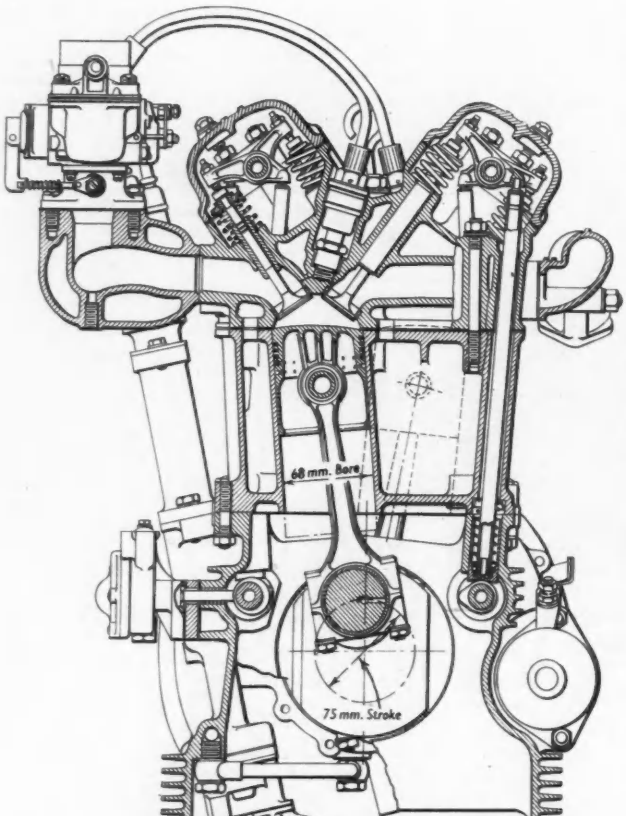


Fig. 15—Single Block Vee Engine of the "Appia"

By far the most interesting part of the "Appia" is the engine; it has four cylinders arranged in vee-form in a single block, the included angle being 10 deg. (Fig. 15). The cylinders are longitudinally offset, a design which allows the cylinder block and the length of the crankshaft to be greatly reduced without sacrificing any water space inside the cooling jacket. The cylinder block is 9½in long and 9in wide, and the short overall length of the engine allows the crankshaft to be carried in two main bearings only. The distance between the bearings centres is 8¼in, i.e. sufficiently small to keep the bending stresses on the crankshaft within reasonable limits. Contrary to the vee six-cylinder engine of the "Aurelia," which has two cylinder heads, one for the three cylinders of each bank, the "Aurelia" engine has one aluminium cylinder head with inserted valve seats and hemispherical combustion chambers to cover all four cylinder bores. The valves are inclined and are actuated by push-rods and rockers from two separate camshafts, carried in three bearings on each side of the cylinder block; the camshafts are driven by a roller chain, kept in tension by an oil-loaded tensioner sprocket. The firing order is 1, 3, 4, 2, and for the purpose of obtaining equal firing intervals the crankpins are phase relative to each other to suit the spacing of the cylinder barrels. The crankcase is a heavily ribbed aluminium casting with a shallow base cover which forms the sump. The engine has a compression ratio of 7·4 : 1 and develops 38 b.h.p. at 4800 r.p.m.

Owing to the very compact shape of the engine the wheelbase of the "Appia" is fully utilised for passenger accommodation without any considerable frontal overhang. The car weighs dry 16 cwt and has a maximum road speed of 80 m.p.h.

The only Spanish exhibit was the Pegaso sports car, fitted with a 2·8-litre vee eight-cylinder engine having a maximum output of 250 b.h.p.

and the "1100 TV," a fast touring car, which is similar to the "New 1100" in practically every respect, except for a modified engine of the same capacity but of higher output. Both cars are of integral construction; they have a four-speed gearbox, with the three upper ratios synchronised, with transmission by a hollow tube with flexible couplings and a hypoid-bevel rear axle. The front suspension incorporates coil springs with double-acting telescopic dampers and a stabilising bar. The rear suspension differs from that of the types "1400" and "1900" in as far as instead of the coil springs and laminated radius arms of those models, ordinary semi-elliptic springs are being used. The four-cylinder 1090 c.c. push-rod-operated o.h.v. engine has a 68mm bore and 75mm stroke. It is fitted with an aluminium cylinder head with valve seat inserts. The engine of the "New 1100" has a compression ratio of 6·7 to 1 and develops 36 b.h.p. at 4400 r.p.m., while the engine of the "1100 TV" model, with a compression ratio of 7·4 : 1 and fitted with a special carburettor, has a maximum output of 48 b.h.p. at 5200 r.p.m.

At the stand of Lancia (England), Ltd., a new small car, the "Appia," first introduced this year at the Turin Motor Show,

Subject Indexing of Aerodynamic Data

THE need for a more mechanised indexing system for aerodynamic data has become increasingly more evident in recent years. For a long time now it has been impossible for a single person to read all the aerodynamic publications available, and it is realised also that existing methods of documentation themselves are inadequate. Furthermore, it does not seem likely that modifications to the present classification systems in order to provide a satisfactory index of specific detailed data will prove satisfactory.

The Nationaal Luchtvaartlaboratorium(N.L.L.) at Amsterdam has therefore published a series of reports* outlining its proposals for a new method of indexing aerodynamic data. The essence of the N.L.L. scheme is the use of edge-punched cards, which can be sorted by mechanical or semi-mechanical methods (the minimum essential piece of equipment is a knitting needle) and which incorporate on the card complete detailed qualitative information of the texts recorded in the document catalogued. It is intended that this card catalogue will cover all dynamic data using, unlike existing indexing published reports and articles containing aero-systems, only one card per report. The fineness of the breakdown of aerodynamics into its constituent subject headings is such that, on the average, some twenty-five headings and sub-headings will be incorporated in the holes of each card, giving a very detailed indication of the contents of the report. The use of edge-punched cards enables sorting for information under either one subject heading or any combination of two or more subject headings. Additional information is printed on the face of the card in the form of small sketches showing the general test set-up and indicating the range of the variables over which measurements were made. It is worth emphasising that the N.L.L. scheme only aims to produce references to relevant papers and give enough information to the user to enable him to decide whether these references contain the kind of data for which he is looking. The cards do not give any results from the reports.

As a result of a recommendation from the Aeronautical Group of Aslib, the Advisory Group for Aeronautical Research and Development of N.A.T.O. has given its support to the N.L.L. As it seems likely that this method of indexing data will be of value to many organisations concerned with aerodynamics, this indexing system has been launched by the N.L.L. on a commercial basis, and subscribers can obtain cards at 2s. 3d. each with an estimated supply of 1000 to 1250 cards a year. The cards and further details of the scheme can be obtained on application to the N.L.L., Sloterweg 145, Amsterdam, W.

Short Notice

Principles of Electronics.—By H. Buckingham, Ph.D., M.Sc., A.M.I.E.E., and E. M. Price, M.Sc. (Tech.). London: Cleaver Hume Press, Ltd., 42a, South Audley Street, W.1. Price 15s. —This book is the ninth in the Cleaver-Hume "Electrical Series," edited by Professor H. Cotton. Its authors assume that readers will be familiar with general circuit theory of direct and alternating currents as dealt with in previous volumes in the series. In the book under review the first five chapters are concerned with the basic theory of the subject of electronics. The next six chapters deal with common items of electronic equipment and the last seven chapters are devoted to various applications of electronics to engineering and industrial problems, including a.c./d.c. conversion, heating and welding, measurements and counting. This book is not intended for students making a specialised study of electronics, but it should prove useful to engineers whose work in other fields of activity brings them into contact with electronic methods and their applications.

* N.L.L. Reports No. F64, F116, F125 and F125a

Fuel Distribution Depot

WE recently were able to pay a visit to Cambridge to inspect the new coal handling depot of Austin Beales and Co., Ltd., in that city. The construction of this yard was the result of a decision to combine the tonnage of four existing depots into one fully mechanised yard, and so effect a considerable saving in the total area required and also in the length of sidings. Existing sidings, ground contours, main drainage and water supplies had to be accommodated in the new scheme, but apart from these limiting factors it was possible to plan the yard to achieve the maximum handling efficiency. Many schemes were considered, such as the use of large silos and wagon tipplers, radial conveyor systems and gravity bunkers, but that finally determined upon called for the design and development of new equipment, and this has been carried out by Charrold, Ltd.

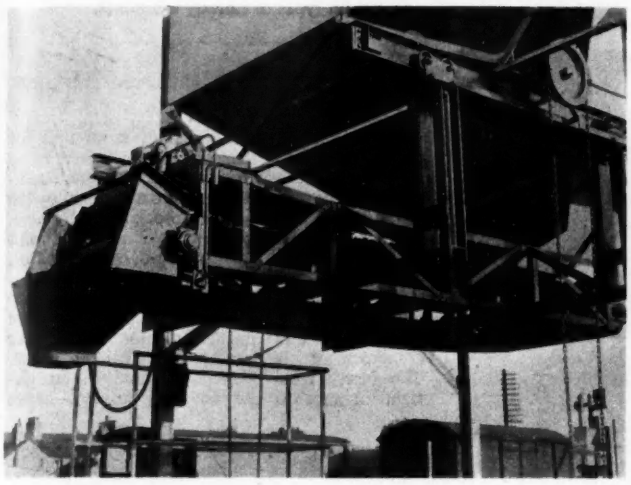
Bulk supplies reach the yard by two sidings and the layout adopted divides the depot into two sections, one for bulk delivery service and the other for delivery of fuel in sacks. The handling area has a concrete surface and is divided into bunkers by walls built of hollow concrete blocks. These walls are unbonded so that they can be readily moved to allow for adjustment of bunker capacity to suit availability of supplies. The movement of coal from truck to bunker and from bunker to hoppers is carried out by a crane and a grab.

There are two hoppers for bulk delivery, each holding about 18 tons and so arranged that a driver can fill a lorry without assistance and can also carry out sack-filling operations. The loading equipment at each hopper consists of a 24in belt conveyor, shown in our illustration, which has two speeds and is free to move in a horizontal direction for a distance of 8ft, so that a lorry can be filled with a trimmed load without moving the vehicle. The stop and start switches are duplicated, one set being arranged at a point convenient for the driver to control the loading of lorries and the other set being mounted at the delivery end of the conveyor for control of sack filling. For the loading of lorries the high conveyor belt speed is used, while the slower of the two speeds is used for sack filling. A hinged chute attachment is provided at the end of the conveyor to assist in sack filling, and the push-button switches give easy control of the flow. An electromagnetic brake provides the sharp cut-off so essential for the filling of sacks.

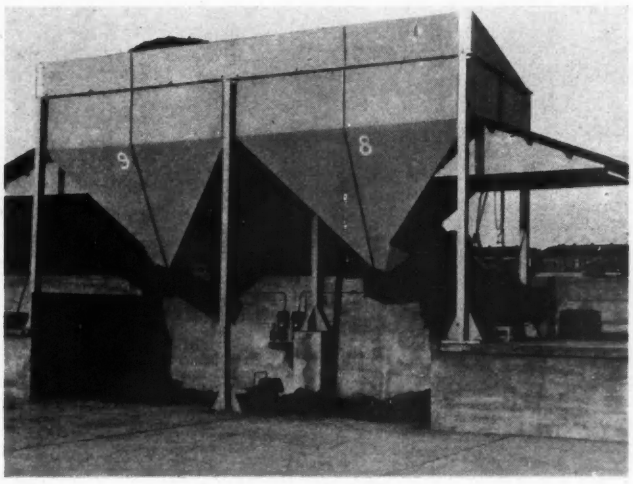
For the weighed sack delivery service there are a number of smaller capacity hoppers, for dealing with a variety of solid fuels, arranged above a loading platform built at the same height as the lorry floor. The coal hoppers are fitted with a Charrold screening loader, shown in an illustration, which provides a reasonable degree of screening and delivers uphill to a discharge point averaging 6in higher than the bottom of the hopper. Push-button control is provided and the coal is moved over the screen, which has a gradually expanding taper, by angle bar slats attached to a moving chain. A four-cell hopper, each cell having a capacity of 7 tons, has been provided for handling special fuels, such as coalite and anthracite, and the loading platform at this point allows for the stowage of bagged fuel. Since the ordinary control gate loses valuable height and is not very suitable for handling fuels of widely varying size, a new horizontal control has been devised. It consists of a horizontal sliding cut-off plate, fitted at the bottom of the cell, which is operated by one hand and gives accurate control over the fuel delivery rate.

The bulk delivery lorries in use are self-unloading and are mainly built of aluminium alloy. The body is hopper shaped and sliding doors, controlled from the rear end of the lorry, allow the fuel to fall at a controlled rate on to a slat conveyor moving over a flat plate in the bottom of the lorry. The fuel from this conveyor falls over a magnetic separator on to a portable conveyor which is driven by a hydraulic motor and can be swung through an arc of 180 deg. to deliver fuel at any point. The photograph which we reproduce herewith shows the lorry in operation.

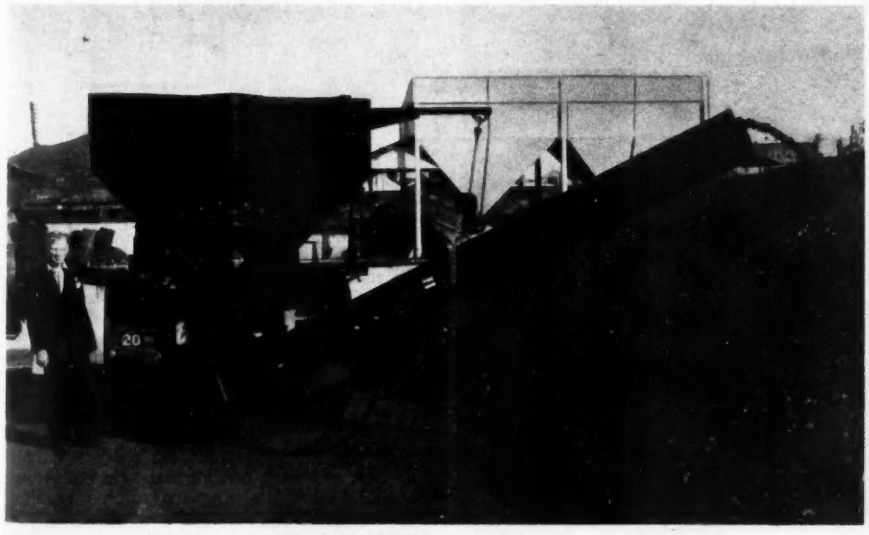
Other buildings in the depot include a sack store, a general store, an engineers' workshop, and a main office which incorporates a weighbridge and wharf office, and also a mess room and washing facilities for the staff.



Bulk Delivery Conveyor



Screening Loader



Bulk Delivering Lorry

"NYPREN" AND "UNIFIRE" CABLES.—"Nypren" cable, made by British Insulated Callender's Cables, Ltd., is designed for use instead of "Pren" cable (a glass-braided, polychloroprene-insulated cable) when there is a possibility of contamination by synthetic lubricating oil which is finding use in jet engines. It is made basically by the addition of a nylon covering to "Pren," to afford a useful degree of protection against the synthetic oil. The diameter of any "Nypren" cable is made the same as the equivalent "Pren" cable by a slight reduction in the thickness of the polychloroprene insulation. At present these cables are only available in the smaller sizes, which are type-approved to Ministry of Supply specification EL1771, Issue I. Another new cable made by the same company is known as "Unifire." It is designed for fire detection and extinguishing circuits and will operate in open flame at 1000 deg. Cent. for not less than five minutes. The composite glass and asbestos insulation is impregnated with various silicone compounds. The cable is type-approved to Ministry of Supply Specification EL1736.

Blithfield Reservoir

On Tuesday, October 27th, Her Majesty Queen Elizabeth the Queen Mother opened the Blithfield reservoir of the South Staffordshire Waterworks Company, which is situated in the valley of the River Blithe about 10 miles north of Lichfield, and adjacent to the village of Abbots Bromley. An estimated reliable gross yield of 16 m.g.d. will be obtained from the new works, the storage capacity of the reservoir being about 4000 m.g. The reservoir is formed by an earthwork dam with a clay core-wall, the height of the dam being about 50ft and its length about 3000ft. A concrete cut-off wall below the embankment extends down to a maximum depth of about 100ft, to the Keuper marl. The catchment of the River Blithe supplying the reservoir is about 27,000 acres in extent.

As may be noted from the first of the accompanying illustrations, the upstream face of the embankment is lined with concrete sheeting, and its top width is 14ft. The discharge tunnel and the overflow form a single rectangular structure, 343ft in length, which is also shown in the first illustration, and is of a massive and rather unusual character. When the reservoir overflows, water spills over the two parallel side walls of this structure and then flows through the spillway channel to the stilling pool, shown in the second illustration; from there, as may be observed, another channel flows back to the river. The discharge tunnel of the reservoir is 14ft in diameter, and passes from the valve tower under the spillway channel. The spillway channel is, in fact, formed on top of the discharge tunnel; its side walls are braced apart with reinforced concrete struts where it passes through the embankment wall, and it is spanned by a bridge at the embankment crest.

The Blithfield reservoir has been built for the South Staffordshire Waterworks Company at an estimated cost of about £850,000. The consulting engineers were G. H. Hill and Sons (Manchester), and the contractor was John Mowlem and Co., Ltd.

Blithfield Reservoir Embankment

Spillway and Stilling Pool

Spherical Roller Bearing

A new form of bearing has been introduced by Skefko Ball Bearing Company, Ltd., and is now available in a limited number of sizes.

Unlike spherical roller bearings of the conventional design, the new bearings have no fixed flanges on the inner ring. A guide ring of comparatively narrow and high section is interposed between the rows of rollers. This loose ring, together with the roller cage, ensures accurate guidance of the rollers.

The rollers are symmetrical and, being independent of the direction of the bearing load, they automatically adjust themselves in the axial plane so that the resultant roller load always acts at the centre of the roller. This is made possible because the guide ring can always take up the required axial position between the rows of rollers. The fact that the rollers position themselves in this manner, makes it convenient to provide such close conformity between rollers and tracks that the load is distributed evenly along the roller length, thus reducing the material stresses to a minimum.

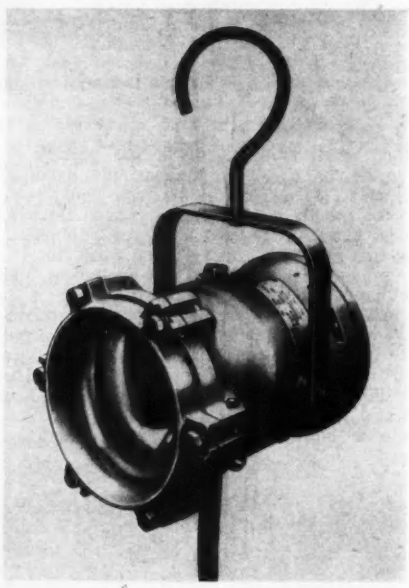
The length of contact between the rollers and the tracks is considerably greater than in the conventional spherical roller bearing. This is due to the fact that it has been possible to increase the roller length and more especially to the fact that there are no grinding reliefs on the inner ring.

All these factors combined to give the new bearing an increased carrying capacity. The design of the cage permits the bearings to be made wider than hitherto, so that bearings with increased carrying capacity can be obtained in cases where the diametral dimension is limited. The makers state that the bearing will be suitable for applications where very wide bearings of low section height and high carrying capacity are desirable, such as rolling mills and certain types of railway axleboxes.

Compressed Air Operated Mining Lamp

An interesting new design of lamp unit for use in mines and other places where there is no mains supply of electric current, but where compressed air is available, has been developed by the Atlas Diesel Company, of Stockholm, Sweden. In this lamp an electric bulb is supplied with current by a built-in air-turbine-driven generator. The lamp is illustrated below.

The metal body of the lamp is divided into two compartments, the front compartment containing a bulb and its reflector and the rear compartment the generator and air turbine. The heavy front glass is secured in an air-tight manner to the body by a rigid flange and rubber seals. This flange coupling is also used to secure the reflector in the body. The bulb is designed to operate on 12V, 150W.



Compressed-Air-Operated Mining Lamp

The generator rotor is a six-pole permanent magnet and it is mounted together with the turbine rotor on a common shaft running in ball bearings. The compressed air supply is delivered through a filter to a built-in reducing valve set to maintain the working air pressure supply to the turbine constant at 42 lb per square inch. With this arrangement any variations in the pressure of the primary air supply are not transmitted to the air turbine, and heavy fluctuations in the generator voltage are avoided. After leaving the reducing valve the compressed air first passes through the pressure tight bulb compartment before entering the turbine nozzles. The use of the bulb compartment as a pressure chamber acts as a safety measure, for if the front glass is accidentally broken the air escapes, and

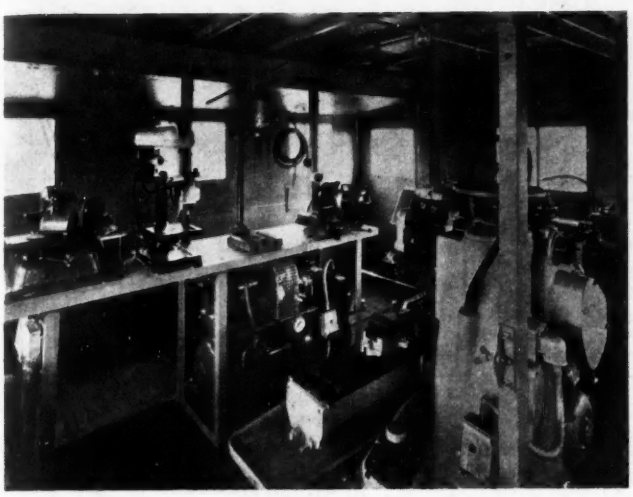
with the consequent loss of pressure the turbine stops and generation of current ceases. An air filter is fitted in front of the reducing valve to prevent any dust in the working air line reaching the valve, nozzles and turbine wheel.

Air is exhausted from the turbine on the outside of the stator and the exhaust flow is directed forwards to cool the unit.

Mobile Workshop

A SELF-CONTAINED mobile workshop for the Agricultural Department of the Northern Rhodesian Government, made by Tractor Spares, Ltd., is illustrated below. It will eventually be used to maintain a fleet of about a hundred tractors employed on land clearance, soil conservation and allied civil engineering projects in the Colony's programme of agricultural expansion. Amongst a comprehensive array of equipment installed is a lathe, milling machine, welding and cutting set, cylinder boring bar, bench and portable drills and grinders, a valve refacer, battery charger and a "Hymatic IS10X" compressor complete with its 40-gallon air receiver. The compressed air supply, cleaned and stabilised at constant pressures by a "Hymatic R50" air rectifier, is used for spray painting and tyre inflation besides the operation of other pneumatic apparatus.

The heavy power load is met by a trailer-mounted 35 h.p. diesel generator plant direct-coupled to a rotating field alternator to provide a 400V, three-phase, 50 c/s supply.



Mobile Workshop

Dry Seal Gasholder

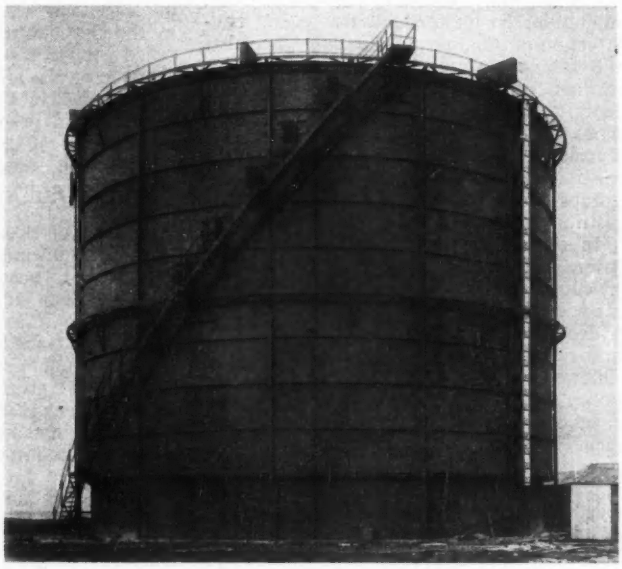
A PHOTOGRAPH we reproduce on this page shows a Wiggins dry seal gasholder which has been built at the Point of Ayr Colliery, near Prestatyn, North Wales, for the National Coal Board by Ashmore, Benson, Pease and Co., Ltd. This design of gasholder is built under American patents and the first installed in this country was one of 10,000 cubic feet capacity at Alston. In our issue of December 28, 1951, we gave some notes on the Alston holder with particulars of the Wiggins principle of gasholder design. The new Point of Ayr holder with its dischargeable capacity of 250,000 cubic feet is the largest of its kind yet built in this country, and it is intended for the storage of methane.

In this design of piston displacement gasholder a flexible impermeable synthetic rubber-coated fabric is used as a sealing medium. The seal is arranged in the form of a continuous flexible cylinder having its lower edge attached in a gastight manner to the piston circumference, and its upper edge to the inner wall of the shell about halfway up its height. The seal is made in two parts, which are connected together at the lower rim of a telescoping fender. This fender serves to prevent the rim of the piston rubbing the seal as it rises and falls, and there are thus actually two seal units—one between the holder shell and the fender and the other between the fender and the floating piston.

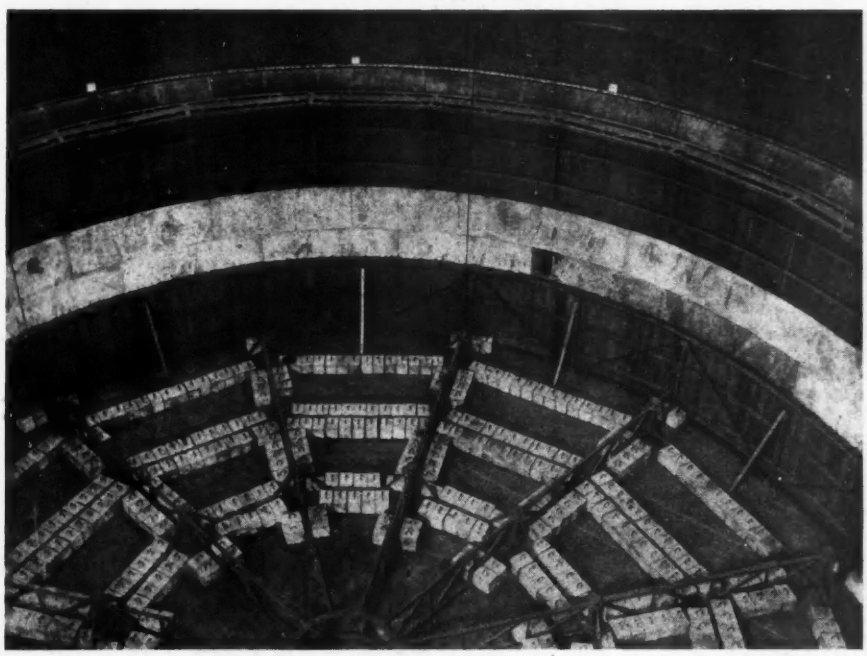
In the second photograph we reproduce, the interior of the new gasholder is shown with the piston in its lowest position. It will be seen that the piston has a vertical fender wall built round its circumference; this wall is 7ft 8in high. The telescoping fender between the piston and the holder shell is just under 17ft high, and it has part of its inner wall covered with steel sheets, on which the piston-to-fender seal rolls as the piston ascends. Just above the upper rim of the telescoping fender there can be seen the upper edge of the seal between the fender and the holder shell. The point where the seal is attached to the shell is 27ft 11in above the holder floor level. Below this point the shell is made gastight and above it the holder shell is fully ventilated by gaps between each tier of shell plates. The main shell is 79ft 9in diameter inside.

Projecting out from the rim of the telescoping fender is a ring, against which the top of the piston fender wall registers when the piston ascends. As the piston continues to rise and lift the telescoping fender the lower seal rolls on the telescoping fender smoothly and without rubbing or abrasion. The piston and fender thereafter ascend as a single unit with the two parts of the seal unrolling below and forming a continuous gastight seal against the holder shell.

When the telescoping fender is in its lowest position it seats upon the top of an inset portion of the holder shell 9ft 3in above the base. This lower shell has an inside diameter of 76ft 5in. The piston rises nearly to the roof of the shell and at its maximum permissible height it contacts a lever which opens a relief valve. The gas pressure within the holder can be adjusted by concrete weights distributed over the piston top. In the Point of Ayr holder gas is to be stored at from 10¼in to 11½in w.g., and the piston is loaded with 864 concrete blocks, weighing 86 tons. An automatic levelling device is fitted consisting of three weights moving in guides equally spaced round the holder. Each weight is connected by cables to opposite points near the piston circumference and through the cables, the weight compensates for any eccentric loading on the piston.



Gasholder with Inspection Doors Open



Interior of Gasholder

A New American Power Policy

(By Our American Correspondent)

THE Eisenhower Administration has now issued a detailed, though partly vague, statement on its policy for the production and distribution of electric power. It clearly indicates that the great public power crusade of the New Deal is dead, and it outlines a shift of emphasis from federal to local enterprise in matters appertaining to the development of hydro-electric power. In transferring responsibility for local power needs to local areas, the new Administration has reversed the policy of two decades of Democratic Government. The new power policy set forth two significant objectives: that limitations be imposed on the federal construction of multiple-purpose dams, and that the sale of federally generated power be through private sources wherever possible. In brief, the policy will mean fewer federal dams and reservoirs constructed by the Bureau of Reclamation, fewer federal transmission lines, and less encouragement to local groups to form co-operative ventures to distribute publicly generated electric power.

In its last session, Congress initiated a severe reduction in federal power projects by cutting the funds available to the Department of the Interior for the construction of hydro-electric schemes, transmission lines and rural electrification projects. This was followed by the announcement of an economy policy by the new Administration, which ruled out, for the time being, the commencement of construction on any new public power projects. The new power policy appears to go a step further and rule out the federal construction of any power project except those multiple-purpose schemes which, "because of size or complexity, are beyond the means of local, public or private enterprise." It may be recalled that the Roosevelt-Truman Administrations' approach to the public power question was to lend active assistance in the organisation of public agencies and co-operatives for the distribution of federal power. This "active assistance" has been a major target of private electric power companies and of many Republicans, who contend that the Democrats "drummed up business" to create a federal power monopoly aiming ultimately at a nationalised electricity supply system. In its statement of policy, the new Administration has pledged to carry out the federal law that gave preference to public agencies and co-operatives in disposing of federally generated electrical energy. It added, however, that it would not permit the "preference privilege" to be used as a means to provide power for large industrial consumers at the expense of domestic and rural customers by either publicly or privately owned power systems. The new Secretary of the Interior has made it clear that, in his opinion, the primary responsibility for supplying the electric power needs of an area rests with the people locally; he feels that the Federal Government does not have "the exclusive right or responsibility for the construction of dams or the generation, transmission and sale of electric energy."

Just what this policy will mean in the perennial conflict between public and private power in America depends on the way it is carried out in specific cases. Large-scale, multiple-purpose schemes involving not only power production, but also flood control, reclamation, irrigation or navigation improvements are clearly in the proper province of federal authority. The integrated development of an entire river basin such as the Tennessee Valley could hardly have been accomplished except through the agency of the Federal Government, working, of course, in closest co-operation with the states involved. The T.V.A. is here to stay, and there are other great basins, such as the Missouri, that stand in urgent need of a planned scheme of water and soil conservation and control so extensive that the aid of the Federal Government is obviously needed for their development. On the other hand, there is not necessarily an overwhelming case for federal action when it comes to schemes for the production of electric power that can be carried out locally under public regulation. The leaning of the new Administration toward private development wherever possible is indicated by its recent withdrawal of objections which were originally raised by the Department of the Interior to a proposed private power development in Hell's Canyon, on the Idaho-Oregon border. Here is a case where advocates of private power say they can produce electric energy more quickly and at less capital cost than the Government, while the defenders of federal power urge a more expensive multi-purpose dam, which they claim would produce far more units of electricity at half the unit cost to the consumer and provide other benefits impossible to achieve if the private project is built. The advocates of public power have already started the political ball rolling on the new power policy. Even before the policy was announced, the Democrats talked about the "great dim-out" and charged that President Eisenhower's views on public power had undergone a "radical change" since the election campaign. They pointed specifically to his praise of T.V.A. during the campaign and to his statement that "power development in the North-West must and will go forward." The ultimate judgment of the American people on the Administration's new power policy will be based on a succession of decisions such as that already made in the Hell's Canyon case. President Eisenhower is unquestionably sincere in his belief that his policy "will serve the best interests of all the people." Many American engineers, however, are not sure that he is right about Hell's Canyon; they tend to reserve judgment on the new power policy until they see how it is carried out in the future.

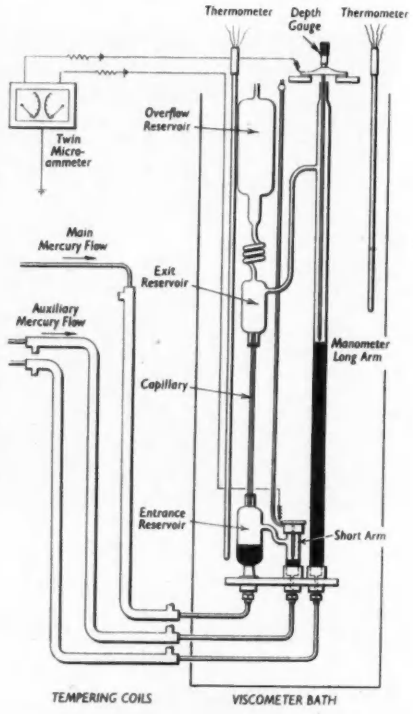
American Engineering News

(By Our American Correspondent)

Adoption of a New Viscosity Standard

From July 1, 1953, the National Bureau of Standards has adopted the value of 0·01002 poise (or dyne-seconds per square centimetre) for the absolute viscosity of water at 20 deg. Cent. as the primary standard for the calibration of standard viscosity samples and viscometers. The date originally proposed for this change was July 1, 1952, but, at the request of the American Society for Testing Materials and the International Organisation for Standardisation, the adoption of the new value for water was deferred for one year to enable member organisations to make the change simultaneously with the N.B.S. Formerly the value of 0·01005 poise had been used widely as the primary reference standard for the absolute viscosity of water. The use of the new value of 0·01002 will result in a reduction of 0·3 per cent in the measured values of viscosity and will make viscosities reported in absolute units correspondingly more accurate.

The new value of 0·01002 poise was obtained recently at the Bureau from an extremely accurate determination of the absolute viscosity of water at 20 deg. Cent. The determination was made by the method of capillary flow. The laws governing laminar flow through an infinitely long capillary are well understood; the only difficulty in their practical application is the evaluation of the end effect in a capillary of finite length. However, by the simultaneous treatment of flow data obtained in two capillaries of the same diameter but different lengths the effects of the ends of the capillaries may be eliminated. The flow data are obtained by inducing a known rate of flow of water in each capillary by means of a calibrated piston and accurately measuring the corresponding pressure drop across the capillary. These measurements, together with the dimensions of the capillaries, give the quantities necessary for the calculation of the viscosity. The capillaries used for the determination were carefully selected by optical means for roundness and uniformity of bore from "FS Precision Bore" capillary glass tubing manufactured by the Fish-Schurman Corporation, of New Rochelle, New York. Diameters of about 0·05cm and 0·04cm were used, starting with a length of about 50cm. After flow tests these tubes were cut approximately in half. The ends of the capillaries were then ground and



Apparatus for Capillary Flow Tests

polished flat and parallel, and their lengths measured directly with suitable gauges. Two methods were employed for the determination of the mean diameter of each tube: in the first the diameter was calculated from the weight of mercury required to fill the capillary bore exactly; in the second the electrical resistance of a column of mercury filling the bore was measured, and the diameter was calculated from the known resistivity of mercury. The values obtained from both methods were in good agreement.

For the flow tests the capillary was mounted between two relatively large glass terminal bulbs to the arms of a differential mercury manometer. The heights of mercury in the manometer were measured from a fixed surface plate by means of pointed depth gauge rods mounted in a micrometer head. Contact of the rods with the mercury surface was determined electrically by passing a weak current at low potential through the mercury and the gauge rod and observing the indication of contact with a micro-ammeter. The viscometer and manometer were mounted together in a large oil bath in which the temperature was maintained within about $\pm 0{\cdot}001$ deg. Cent. of the desired 20 deg. Cent. The various known rates of flow were induced in the capillary by injecting mercury into the terminal bulb at the entrance end of the capillary at known constant rates, displacing the water through the capillary. The mercury was injected by means of an accurately ground and lapped piston driven at a uniform rate through suitable gears by a synchronous motor operating on a controlled frequency source of current. The desired rates

of flow were obtained by choosing appropriate gear combinations. The delivery rate of the piston was calibrated by weighing quantities of mercury displaced by the travel of the piston through a number of increments of its stroke. From such data the mean rate as well as variations in the rate of displacement of mercury by the piston were determined. The injector piston was maintained in a thermostatically controlled oil bath to eliminate the effect of temperature variation on its rate of delivery. Flow measurements were obtained with four capillaries, which were identified as follows :—

Capillary designation	Nominal dimensions Diameter, cm	Length, cm
2·5	0·05	49
2·5*a*	0·05	24
1·4	0·04	45
1·4*a*	0·04	23

To minimise any uncertainties introduced by the effects of the ends of the capillaries or by inaccuracies in measuring their diameters the calculations were made using the flow data for the capillaries in the four possible combinations of pairs involving a long and short capillary.

Pair of capillaries	Viscosity Observed poise	Mean poise
2·5 and 2·5*a*	0·010022	0·010018
1·4 and 1·4*a*	0·010014	
2·5 and 1·4*a*	0·010022	0·010020
1·4 and 2·5*a*	0·010018	

The final result obtained from these data is 0·010019 poise with a standard deviation of ±0·000003.

A High-Pressure Steam Turbo-Generator

The American Gas and Electric Service Corporation has ordered an interesting 125MW tandem-compound turbo-generator for installation at the Philo power station, near Zanesville, Ohio, of the Ohio Power Company. The design of this unit, which was developed in co-operation with the General Electric Company and the Babcock and Wilcox Company, introduces a number of important new concepts in thermal power generation practice : a feed water inlet pressure of 5500 lb per square inch, a turbine throttle pressure of 4500 lb per square inch (being well above the critical pressure of steam of 3206 lb per square inch), an initial steam temperature of 1150 deg. Fah., and a two-stage reheat arrangement with a first reheat steam temperature of 1050 deg. Fah. and a second reheat steam temperature of 1000 deg. Fah. It is expected that based on these extremely high values an overall thermal efficiency of more than 40 per cent will be obtained.

A diagram of the " super-critical pressure " steam cycle to be employed is reproduced herewith. It is still in preliminary form and may possibly be somewhat altered in the final design. The diagram shows that the proposed design involves seven stages of feed water heating, low and high-pressure feed pumps, and a main steam flow of the order of 675,000 lb per hour. A " Universal Pressure " steam generator will be supplied by the Babcock and Wilcox Corporation to provide steam for this high-pressure, high-temperature cycle, and it will be the first time that such a steam generator will be used in a commercial installation in the United States. It is of the so-called " once-through " design : water is pumped at one end and superheated steam is taken at the other end, but although the steam generator acts like a single continuous tube from one end to the other, it is made up of many sets of tubes in parallel. To ensure the uniform and predictable distribution of water between these many passes, a high-pressure drop of 1000 lb per square inch is taken between the feed water inlet header and the superheater outlet header. At full load the feed pumps must therefore supply water to the feed header against a pressure of 5500 lb per square inch. To withstand these very high pressures the entire high-pressure side of the steam generator, except the headers, is made up of small-diameter tubing of considerable thickness, varying in composition from carbon steel at the inlet to stainless steel at the outlet. As this is a " once-through " unit there is no need for the usual high static head to provide circulation and separation of the steam and water. The steam generator can thus be built into a small space, which represents one of the major advantages inherent in this particular design. The steam generator has been designed to deliver 675,000 lb per hour of steam at 4500 lb per square inch and 1150 deg. Fah., as well as to reheat approximately 615,000 lb per hour of steam at 1150 lb per square inch and 800 deg. Fah. to 1050 deg. Fah., and 525,000 lb per hour of steam at 165 lb per square inch from 630 deg. Fah. to 1000 deg. Fah.

Crushed coal will be fired to the steam generator unit through three Babcock and Wilcox " Cyclone " furnaces. Liquid slag will be tapped out of the latter into a small primary furnace into which the " Cyclones " fire and will then be taken to a water-filled slag tank. Gas leaving the primary furnace will be mixed with cool recirculated gas to give a gas temperature of 1900 deg. Fah. before entering the convection surfaces. This procedure will ensure clean surfaces in the convection pass. Some of the gas leaving the convection surface of the reheaters and the superheater passes to the recirculation fans ; most of it goes to a tubular air heater and thence to the induced draught fan and the stack. No separate fly-ash removal equipment will be provided because the "Cyclone" furnaces will remove all but a small amount of exceedingly fine ash, which will be easily dispersed by the high stack velocities. The pressure in the steam generator will be controlled solely by the discharge pressure of the feed pumps. A pressure regulator at the turbine throttle will therefore control the pump speed rather than the firing rate, as in other installations. The heat input to the unit will be controlled primarily by the main steam flow and temperature. The temperatures at the two reheat points will be controlled by the action of dampers in the gas passes leaving the reheater and superheater surfaces.

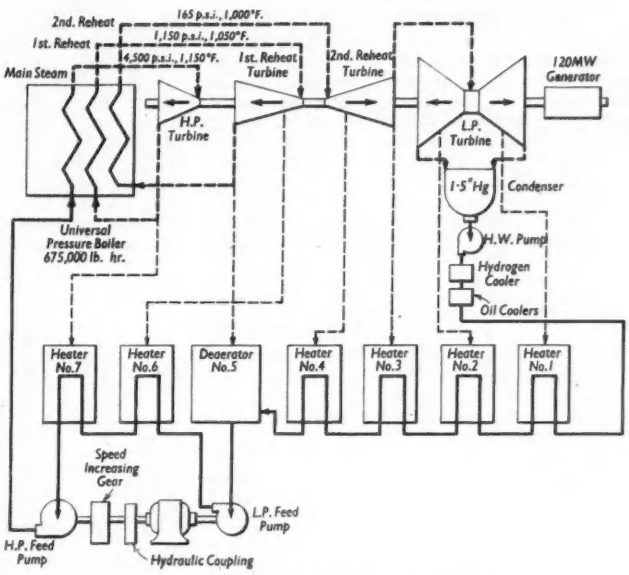


Diagram of " Super-Critical Pressure " Steam Cycle

Special provisions will be made to cope with the starting and transient conditions expected with this steam generator. Recirculation valves with pressure breakdown orifices will be provided to permit fluid circulation through the unit during these times. The fluid circulated through these valves will flow to the de-aerator, which in turn will pass any excess heat in the form of saturated steam to the condenser for removal from the cycle. Carefully controlled desuperheating arrangements will be required to prevent excessively high temperature steam from reaching the de-aerator or the condenser. The operation of these recirculation valves will be automatic, to provide the protection necessary during transient conditions.

A 125MW turbo-generator for this installation will be manufactured by The General Electric Company. The machine will operate at 3600 r.p.m. and will have a special high-pressure turbine in tandem with a machine of the reverse flow type. Steam at 4500 lb per square inch and 1150 deg. Fah. will flow through four steam leads from the steam generator to four pairs of stop and control valves situated under the front of the machine. The control valves will be throttling valves to vary the load on the machine by varying the steam pressure to the first stage. At full load, steam will be exhausted from the high-pressure turbine at 1225 lb per square inch gauge and will return to the steam generator where it will be reheated, to 1050 deg. Fah. It will then re-enter the mid-section of the high-pressure rotor of the reverse flow section and turn forward through several stages before exhausting to the second reheater at 185 lb per square inch gauge. The steam then will return at 1000 deg. Fah. to the mid-section of the turbine adjacent to the inlet from the first reheater and flow through several stages before crossing over to the double-flow low-pressure section. Intercept valves will be provided in each of the two hot reheat lines to protect the machine from overspeeding in the event of a trip-out.

Because of the high temperatures involved the stop valves, control valves, steam leads, flanges, and part of the inner shell of the high-pressure machine will be constructed of austenitic material. Studies are now being made by The General Electric Company to determine whether the rotor of the high-pressure machine can safely be made of ferritic material with a provision for steam cooling or whether it will be necessary to include an austenitic material in the highest temperature zones. The high-pressure machine will utilise a double-shell construction which allows the lower temperature part of the inner shell and all of the outer shell and its fittings to be made of ferritic materials. The remainder of the turbine, from the first reheat point to the condenser, will be fabricated entirely of ferritic material. The turbine will be equipped with an initial temperature regulator, which will sense the steam temperature at the turbine throttle, or some function of that temperature, and will close the control valves in the event of the temperature dropping either too low or too fast. This will protect both the steam generator and the turbine by preventing conditions such as the sudden carry-over of water in the event of loss of fires.

The generator itself will be hydrogen-cooled, and it is intended to operate at a gas pressure of 30 lb per square inch. The machine will be connected directly to a single, three-phase step-up transformer with forced oil, forced air cooling, which will be connected on its high-voltage side to a 132kV station busbar.

The feed pumps will be manufactured by the De Laval Steam Turbine Company. At present two alternate arrangements of pumps are under consideration : both will provide two sets of pumps, each set having a capacity of 60 per cent of full-load flow and having variable-speed hydraulic throttle pressure. The two arrangements being considered are as follows : as shown in the diagram, feed water is taken from the de-aerator by two constant-speed feed pumps of conventional design and pumped to approximately 2000 lb per square inch. The water is then fed through the two top feed water heaters and heated up to approximately 515 deg. Fah. It then enters two specially designed variable-speed pumps, which boost the pressure to 5500 lb per square inch. Each set of pumps is driven by a common motor, i.e. one end of the motor shaft is coupled to one of the constant-speed low-pressure pumps, and the other end is coupled to the variable-speed coupling and step-up gearing driving one of the high-pressure pumps. This arrangement has the advantage of eliminating heaters as well as piping and valves

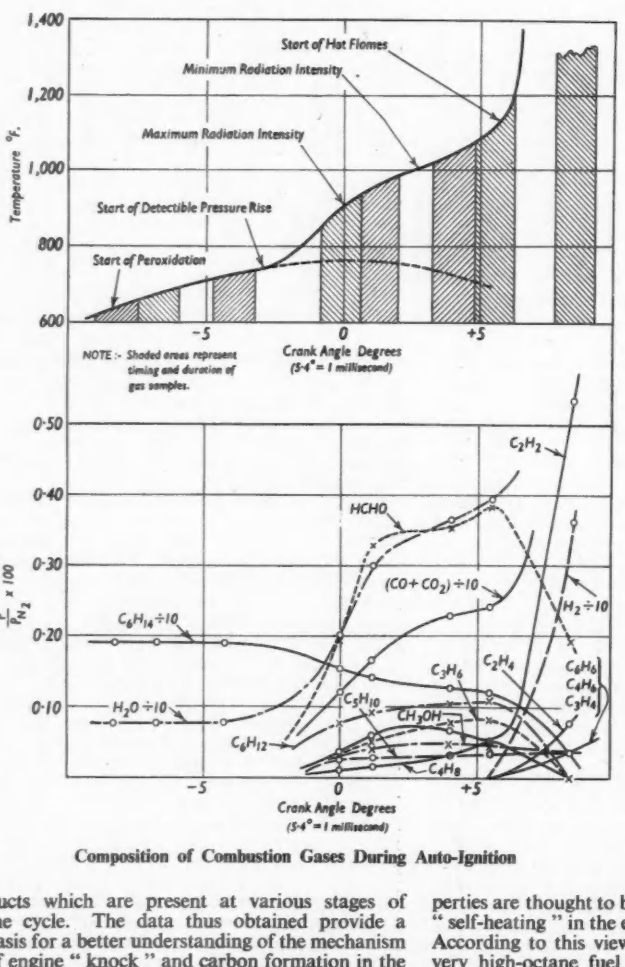
having to cope with a pressure of 5500 lb per square inch. It has the disadvantage, however, of the requirement of pumping hotter water, with its slight thermodynamic loss, and of requiring in effect twice the number of pumps, with the attendant increase in first cost and maintenance.

The other arrangement under consideration calls for the feed pumps to be single, high-speed pumps situated under the de-aerator and pumping the feed water through two high-pressure heaters at 5500 lb per square inch. This makes for a simpler arrangement but calls for the development of feed water heaters to stand the very high water pressure as well as for the use of additional valves and piping suitable for this pressure. Further studies are continuing on the economics of these two arrangements.

Investigation of Auto-Ignition at the National Bureau of Standards

Current research on engine combustion, which is being conducted at the National Bureau of Standards, is providing much valuable information on the chemical processes which take place within the cylinders of an i.c. engine during the combustion cycle. By use of a very fast acting valve, it has been possible to take samples of the rapidly changing combustion gas over extremely short intervals. The analysis of these samples has yielded detailed knowledge of the proportions of the reactants and the products which are present at various stages of the cycle. The data thus obtained provide a basis for a better understanding of the mechanism of engine "knock" and carbon formation in the cylinders. As the compression ratios of modern petrol engines are raised continually, increasing difficulty is being caused by "knock" and pre-ignition. The rapidly expanding use of diesel engines has also emphasised problems of cold starting and engine roughness and smoking under heavy-load operation. All these difficulties are believed to be associated with the combustion phenomenon known as "auto-ignition," which occurs when a fuel-air mixture is heated by compression until it ignites spontaneously without spark. Fuel injected into the hot air in a diesel cylinder ignites by this process, while "knock" in a petrol engine is caused by explosive auto-ignition of the last, unburned portion of the fuel-air mixture to be traversed by the normal flame from the spark plug. The apparatus used at the N.B.S. engine fuels laboratory for the investigation of auto-ignition includes a special single-cylinder engine of variable compression ratio in which a wide range of operating conditions may be simulated. The engine has been modified to permit the compression-ignition of a single homogeneous premixed charge of fuel and air in the absence of burned residual gases, cylinder hot spots, and lubricating oil. Pressure, rate of change of pressure, and light emission are recorded by means of an oscillograph as functions of crank angle or time. At any pre-selected time during the course of the reaction the special sampling valve can be used to remove a sample from the reacting mixture during an interval of about 0·2 to 0·3 millisecond. The use of this valve enables the reaction to be followed by mass-spectrometric means.

Experiments have been carried out in the single-cylinder engine on a number of hydro-carbon fuels of various chemical structures. In general, it has been found that the auto-ignition of a paraffinic hydro-carbon occurs in a series of steps. The first detectable reaction is the formation of peroxides at a temperature between 600 deg. and 800 deg. Fah. At a somewhat higher temperature, after peroxide concentration has become appreciable, a blue luminescence called the "cool flame" appears, accompanied by a substantial increase in temperature and pressure. When the temperature has risen to about 1100 deg. Fah., the rate of reaction suddenly increases at a rapid rate as the "hot flame" begins. The accompanying violent pressure rise initiates a pressure wave which is reflected back and forth across the combustion space, causing audible knock. An investigation of many pure hydro-carbons, iso-octane-n-heptane blends, and oxygen-containing compounds has shown that as the octane number and resistance to auto-ignition increase, the temperatures at which peroxides and cool flames are first detected also increase while the amount of heat released during the "cool flame" decreases. Over a wide range of fuel-air ratios, however, the temperatures at which "hot flames" first appear lie in the same temperature range (1100 deg. Fah. ±50 deg.) for all the aliphatic compounds covered. Because the octane numbers and auto-ignition resistances of the fuels investigated vary widely, these properties are thought to be functions of the extent of "self-heating" in the early stages of the reaction. According to this view of the overall process, a very high-octane fuel must be heated by compression alone to nearly 1100 deg. Fah. before "hot flames" begin, whereas a low-octane fuel may contribute several hundred degrees of the required temperature rise by its own early reactions. Thus, the ease with which low-octane fuel auto-ignites is believed to be due to the large contribution of the "cool flame" reactions in raising the mixture temperature to the necessary 1100 deg. Fah. The fact that the "hot flame" stage of combustion begins at very nearly the same temperature for all fuels may indicate that this stage takes place as the result of the production of a single essential intermediate compound during the earlier stages of reaction. On the other hand, the reactions which have been found to occur may be common to all the fuels covered by the investigation.



Composition of Combustion Gases During Auto-Ignition

While n-hexane was being used as a fuel in the variable-compression engine, eight samples of the combustion gas were removed and analysed in the mass spectrometer. The mixture composition was then plotted as a function of time during auto-ignition. In the lower part of the accompanying diagram the concentration of each component as determined in the mass spectrometer is shown in terms of its partial pressure referred to the partial pressure of nitrogen in the mixture. The shaded areas in the upper curve represent the timing and duration of gas samples. The samples were taken over the period from the start of peroxidation until the "hot flame" was well under way. The dotted line in the upper curve represents the temperature-time relationship for a non-reactive mixture in which auto-ignition would not take place. When a lean mixture was used, no large change in chemical composition occurred between the start of peroxidation and the beginning of intense "cool flames." During the "cool flame," however, the hexane decomposed into several olefins, acetylene formaldehyde, carbon monoxide, carbon dioxide, and water. By the time the "hot flame" began, only about one-third of the hexane had decomposed, and this small amount of fuel had undergone sufficient oxidative degradation to cause a temperature rise of about 450 deg. Fah. In the early part of the "hot flame" most of the original fuel and fragments, including formaldehyde, were decomposed, while hydrogen and acetylene were formed in large quantities along with small amounts of di-olefins and benzene. Other sample analyses made with a series of branched and cyclic paraffins have shown that these fuels all produce olefins, carbon oxides, and water during the early reactions. The lower-octane fuels give larger quantities of these products, and, in addition, produce formaldehyde and acetylene during the "cool flame." The rapid increase of acetylene (C_2H_2) concentration in the "hot flame" is one of several findings which tend to corroborate the results obtained in the past year by R. E. Ferguson. These results suggest that acetylene is an important intermediate in the "hot flame" combustion of hydro-carbons. Work is now being carried on at the Bureau to determine the part played by acetylene in the earlier stages of combustion. There is also considerable evidence, both from the studies at the N.B.S. and from those at other laboratories, that acetylene may be the essential intermediate in carbon formation in burning mixtures. Carbon is readily formed in knocking combustion in engines, even with lean mixtures, and this may indicate that the formation of carbon from the acetylene present is a faster reaction than the direct oxidation of acetylene under these conditions.

Technical Report

Properties of Soluble Cutting Oils: Tests on Soluble Cutting Oils, Part I. Melton Mowbray: Production Engineering Research Association of Great Britain.—The distribution of this report has hitherto been confined to members of the association, but it is now being generally released. The general object of the tests was to determine the relative effects of selected soluble cutting oils on the efficiency of four common machining operations, and to observe certain physical and chemical properties of the oil. The introduction to the report points out that there is a great need for quantitative data on the effects which cutting fluids have on tool life, permissible cutting speeds, finish, &c., and corresponding information on such phenomena as corrosion effects, fuming, physiological factors, &c. As a first step towards providing the engineering industry with this long needed information, P.E.R.A. undertook a series of tests. In order to produce results in the shortest possible time it was decided to confine the first series of tests to soluble cutting oils and to drilling, turning, milling and grinding of those steels representative of those used in industry.

The report is being compiled in six parts owing to the diverse nature of the tests and machining operations covered by the investigation. Following this first report dealing with the specification of the cutting oils and various preliminary tests, subsequent parts of the report will deal with the machining tests and in the sixth part there will appear a summary of the whole investigation.

Industrial and Labour Notes

Industrial Production

The index number of industrial production (1948=100), which is prepared monthly by the central statistical office of the Treasury, has been estimated provisionally at 105 for all industries in August, compared with 110 in July. Figures for the corresponding months of last year were 98 in August and 102 in July. Both July and August are, of course, affected by annual holidays. Taking the various industrial groups, the index figure for mining and quarrying was 92 in August this year, compared with 94 last year, and that for manufacturing was 106, compared with 97 a year earlier. The Treasury says that, according to information so far received, the index for all industries in September this year is expected to be 125 or 126.

Export Sales Conference

An export sales conference, organised by the Federation of British Industries, was held at Buxton last week-end, under the chairmanship of Sir Harry Pilkington, president of the F.B.I. The conference was attended by 150 representatives of exporting firms of all sizes in almost every branch of British manufacturing industry. For most of the time these representatives were divided into six discussion groups dealing with technical and practical questions of procedure, distribution, staffing, trade promotion, and other aspects of export selling.

The detailed findings of the discussion groups are to be published later. One point of particular interest raised by the groups related to trade fairs and exhibitions. It was agreed that these were a valuable form of trade promotion, but it was felt that, in view of the large number of such fairs, there was need to coordinate industrial policy concerning them, and that firms must be selective in choosing in which fairs to participate. It was also thought that it might be possible to draw up short lists of the exhibitions and fairs most suited to particular industries. British goods, it was suggested, ought to be displayed in the appropriate trade section where they could be compared directly with the goods of this country's competitors, rather than in a separate British pavilion. On the subject of long-term methods of export promotion, the discussion groups emphasised the value of long-term educational promotion, such as the supply of laboratory equipment and textbooks to foreign universities, the training in this country of overseas engineering graduates, and the wider distribution overseas of British trade and technical journals.

Throughout the conference there was, of course, consideration of export policy generally. Among the points brought out was that Britain's interest was in an expansion of world trade as a whole, rather than in all countries competing together for larger shares of the existing volume of trade, and it was pointed out that more capital investment overseas was the means through which that expansion in world trade must come. Economically sound development projects overseas, it was urged, increased the purchasing power of the countries concerned and so in turn their ability to buy more from us and others. A bold policy of capital development, the conference asserted, was needed both on the part of the Government and of the private investor.

The T.U.C. and Public Ownership

The Trades Union Congress has made some further comments on its interim report on public ownership, which was issued at the end of August. It says that, despite obvious improvements in industrial relations which public ownership has brought, some groups of workers have strongly criticised the new order of things. They have made charges about "too many bosses" and "too many office staff" and have shown disappointment with their chances to take an active part in the running of the industry.

The T.U.C. main comment on this point is that, just as nationalised boards might do more explaining through trade union representatives about the size and duties of their staffs, so the trade union movement itself, through education and propaganda, might campaign to bring its members up to date on current thinking about industrial relations. "Workers' control," the T.U.C. comments, does not stand as the official policy of the British trade union movement. Since 1944, it has been the policy of the T.U.C. that, while trade union experience should be one qualification for membership of public boards, trade unions should not seek direct representation on the boards, but should exercise influence through consultative machinery. The T.U.C. adds that criticisms of the nationalised industries have naturally received much publicity, which has tended to cloud the achievements of improved industrial relations generally within those industries. It feels, nevertheless, that there is sound purpose in examining with the unions concerned such problems as the complaint that consultative machinery is over-centralised or the suggestion that in all the nationalised industries the function of negotiation and the exercise of consultation should be separated.

Changes in Wage Rates

The Ministry of Labour has stated that changes in wage rates reported to have come into operation in the United Kingdom during September resulted in an aggregate increase estimated at approximately £221,000 in the weekly full-time wages of about 926,000 workpeople, and in a decrease of about £300 for 12,000 workpeople. The decreases, which operated under sliding scale arrangements based on the index of retail prices, affected workers in the iron and steel industry in a few districts and iron ore miners and limestone quarrymen in Northumberland. Those receiving increases in September did not include any workers in the engineering or allied industries. The Ministry's report shows that, in the first nine months of this year, changes in wage rates resulted in an aggregate weekly increase of £1,875,300 in the weekly full-time wages of 6,931,000 workpeople, compared with an increase of £3,173,000 in the wages of 8,058,000 workpeople in the corresponding period of 1952.

The increases becoming operative in September moved the index of rates of wages (June 30, 1947=100) up one point to 137 for all workers. At the beginning of this year the index stood at 134.

National Joint Advisory Council

On Wednesday of last week the Minister of Labour's National Joint Advisory Council held its quarterly meeting in London. A subsequent statement about the proceedings said that the council was informed of the action taken to stimulate the widest possible discussion on the recommendations made in the first report of the National Advisory Committee on the Employment of Older Men and Women. The Minister of Labour, Sir Walter Monckton, Q.C., who presided at the meeting, pointed out that the employment of older people could not be achieved, beyond a very limited extent, by Government action. He said that it required essentially a sharp change in the attitude of mind of many employers, workers and others up and down the country, towards the employment of older workers and towards retirement.

The council also discussed the economic situation on the basis of a report covering the quarter ended August 31st. Another report which was submitted dealt with employment and unemployment on a regional basis and included the latest statistics of short-time and overtime working. It was stated that, between May and August, short-time working showed a further reduction from 62,000 (1·1 per cent of the operatives covered) to 30,000 (0·5 per cent), the figures reported being the lowest since March, 1951. Overtime working had again increased slightly between May and August, there being 1,324,000 operatives who had worked a total of 10,545,000 hours' overtime. Reference was also made to a decision taken by the council last February that the Minister of Labour should approach selected industries about the extension of double day-shift working. It was stated that the Minister's letter (the contents of which were summarised in these notes in our issue of September 4th) had been sent to 113 organisations, the majority of which had accepted the principle of double day-shift working.

Prices and Wages

Speaking in London last Monday evening, the President of the Board of Trade, Mr. Peter Thorneycroft, said that although in the last two years import prices had fallen by 17 per cent, the whole of that potential competitive advantage had been more than absorbed by wage increases during the same period. This country's imports in 1951, he continued, would have cost £100 million less at 1952 prices, which would have been a substantial advantage, but during that period wages and salaries rose by between £500 million and £600 million

From that, Mr. Thorneycroft went on, he did not argue that no wage rate should have changed, and still less that earnings should not rise with productivity. We could be proud, he said, of the statesmanship of our trade union leaders through the post-war period. But what he did appeal for was a sense of caution, for this country was at a moment of great peril in the export field. Whilst the country's competitive position was sound, it was not so strong that it could give an inch of advantage to its competitors. It was clearly in the national interest to slow or stop the upward surge of prices, Mr. Thorneycroft added. Rising prices at home could be both the consequence of inflationary pressure and the cause of another turn in the inflationary spiral; rising prices abroad could spell the difference between success and disaster in our export effort.

Industrial Disputes

During September there were 161 stoppages of work through industrial disputes reported to the Ministry of Labour. In addition, there were still in progress at the beginning of that month sixteen stoppages which had started earlier. In these 177 stoppages of work 25,600 people were involved directly and indirectly during September, the aggregate number of working days lost in the month being 105,000. The Ministry of Labour says that in the first nine months of this year there were 1217 stoppages of work through industrial disputes, involving 196,800 workpeople and causing a loss of 838,000 working days. In the comparable period of last year there were 1327 stoppages, which involved 294,000 workpeople and resulted in an aggregate loss of 1,440,000 working days.

Coal Production

Last week, coal production in this country totalled 4,602,900 tons, of which 4,386,300 tons was raised from the deep mines and 216,600 tons came from opencast workings. The total output for the first forty-three completed weeks of this year was 183,488,700 tons, compared with 186,163,300 tons in the corresponding period of last year.

The Ministry of Fuel and Power has stated that in the week ended October 24th colliery manpower numbered 710,100, the number of face workers being 299,000. Total absenteeism in that week was 12·63 per cent (compared with 12·16 per cent a year earlier), and the output per manshift at the face was 3·193 tons. Distributed coal stocks on October 24th totalled 18,582,000 tons, compared with 19,286,000 tons on the corresponding date last year.

Notes and Memoranda

Air and Water

CIVIL AVIATION IN NIGERIA.—The annual report of the Department of Civil Aviation in Nigeria for 1951/2 has been published and can be obtained from the Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

SHIPBUILDING ORDERS.—The First Lord of the Admiralty was asked in Parliament last week if he was satisfied that new orders were coming into British shipyards at a rate necessary to replace deliveries. Mr. J. P. L. Thomas, the First Lord, said in reply that in the first nine months of this year licences were issued for the construction of 103 new merchant ships, totalling 323,000 gross tons. During the same period, 165 new merchant ships with a total tonnage of 857,000 gross tons were delivered. The First Lord added that the shipbuilding industry's current order book of 5,800,000 gross tons represented more than four times the current annual rate of shipyard output.

FIGHTER AIRCRAFT ORDERED FOR EUROPE.—An order for Hawker "Hunter" fighters has been placed by the Belgian Government for construction by the Belgian aircraft industry. The principal part of the order—approximately two-thirds—concerns Avions Fairey S.A., of Gosselies, where the aircraft will be assembled from major components supplied by the Dutch aircraft industry. The Belgian firm, S.A.B.C.A., will assemble about one-third of the total order, and will also manufacture wings and undercarriages. A further order for "Hunters" has been placed with Belgium under the "off-shore" supply scheme for the N.A.T.O. programme. Of this order, three-quarters will be built in Belgium from Category "D" components supplied direct by the Hawker Aircraft Company, Ltd. These components will be delivered by an air-lift system operating direct to the airport at Gosselies, Belgium, as has been the practice with "Meteors" also built in Belgium. The engines for both the Belgian and Dutch "Hunters" are to be built under licence in Belgium by Fabrique Nationale.

Miscellanea

SELLING PRICES FOR TUNGSTEN ORES.—The Ministry of Materials has announced that as from October 28th its selling price for tungsten ores of standard 65 per cent grade and ordinary quality has been reduced as follows: wolframite from £14 to £13 10s., and scheelite from £13 10s. to £12 15s. per long ton, delivered consumers' works.

1954 BUILDING PLANT EXHIBITION.—The 1954 Building Plant Exhibition, organised by the Ministry of Works, will be held at Reading from Thursday, June 24th, to Wednesday, June 30th, inclusive. The site for the exhibition is Hills Meadow, immediately below Reading Bridge, and the total space available is approximately 300,000 square feet.

4FT. BATTEN FITTING FOR "MAZDA" FLUORESCENT TUBES.—The British Thomson-Houston Company, Ltd., has introduced a new 4ft fitting known as the "Monolux Junior" for fluorescent lighting. The new fittings are for use with 4ft. 40W bi-pin lamps. They incorporate the B.T.H. "Pendicone" method for rapid installation and the new design of choke. The fitting is available in "instant start" and "switch start" versions.

BRITISH ROAD FEDERATION.—Photographic evidence of the state of Britain's main industrial roads is set out in the British Road Federation's latest publication, "No Road." The pictures show how the movement of industrial supplies is hampered by bottlenecks, sharp turns, hump-backed bridges and congestion. The conditions shown are not exceptional, the Federation states, and countless other examples exist throughout the country.

HIGH-SPEED CINEMATOGRAPHY.—We have received a booklet entitled "Time Microscopy," which describes the high-speed cinematography facilities offered by John Hadland and Co., Scatterdells, Chipperfield, Herts. This company is equipped with cameras operating at 3000 frames per second, using normal 16mm film. Having observed a high-speed process or mechanism in this manner, the film is then projected at the much slower speed of about 15 frames per second.

ASSOCIATION OF VERMICULITE EXFOLIATORS.—There has recently been formed the Association of Vermiculite Exfoliators. Its aims are to establish and maintain recognised standards of quality for processed vermiculite and to prepare codes of practice for all commercial applications. In addition, the association intends to encourage and conduct research into the uses of vermiculite. The address of this new association is Plantation House, London, E.C.3 (telephone, Mansion House 9345).

NATIONAL FUEL EFFICIENCY EXHIBITION.—A National Fuel Efficiency Exhibition is to be held at the City Hall, Manchester, from November 18th to 28th. In conjunction with the exhibition, the Combustion Engineering Association is arranging a conference on "Industrial Fuel Efficiency." It will take place at the Grand Hotel, Manchester, from November 18th to 20th. Full details of the conference can be obtained from the Combustion Engineering Association, 6, Duke Street, London, S.W.1.

CONFERENCE ON WATER RESOURCES DEVELOPMENT.—Under the auspices of the Economic Commission for Asia and the Far East, a regional technical conference on water resources development will be held from May 17 to 22, 1954, in Tokyo, Japan. The purpose of the conference, it is stated, is to provide an opportunity, particularly to those in Asia and the Far East, to participate in an inter-regional exchange of views and experiences gained on those aspects of water resources development which are of paramount importance to this region and are generally not dealt with by other international technical organisations.

PRODUCTIVITY IN HOUSE-BUILDING.—The results of a survey of productivity in house-building by the Building Research Station, D.S.I.R., is now published as National Building Studies, Special Report, No. 21. It is concerned with contracts for three-bedroom, two-storey houses built for local authorities and completed between January, 1949, and March, 1951. Information was extracted from the main contractors' records of 177 completed contracts and from more than 1000 subcontractors who were employed on them. The data collected in the survey related mainly to the labour expenditure per house and particularly to the man hours required by the individual trades.

RADIOISOTOPE CONFERENCE.—A radioisotope conference, arranged by the Atomic Energy Research Establishment, Harwell, is to be held in Oxford from July 19 to 24, 1954. It will be similar to the conference arranged by Harwell in 1951 in Oxford and will deal with developments in recent years. On the first three days of the conference the papers presented will deal with applications in medicine (experimental rather than routine uses), biology and agriculture. The remainder of the meetings will be concerned with chemical, physical, engineering and general industrial applications. An exhibition of instruments and techniques for radioisotope users will be held in Oxford during the conference. Application forms can be obtained from the Conference Secretary, A.E.R.E., Harwell, Didcot, Berks.

AIR AND WATER POLLUTION.—The Organisation for European Economic Co-operation has arranged for a technical mission to visit a number of European countries to study methods of dealing with air and water pollution caused by the chemical industry. While it is in this country the mission will visit the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research at Watford, and the works of the following firms: Courtaulds (Preston), British Enka (Aintree), Shell (Stanlow), Monsanto Chemical Company (Ruabon), and May and Baker (Dagenham). The mission is not directly connected with either of the committees appointed by Ministers to consider the wider problems of air pollution and the pollution of rivers in general. The mission is not dealing with the problem of "smog," which is caused by the combustion of coal in general, since this is not a special problem of the chemical industry.

U.K. MANUFACTURERS HOLDING CANADIAN STANDARDS ASSOCIATION APPROVAL.—The 400 manufacturers of electrical equipment who have now obtained approval of their products for export to Canada are listed in a publication which can be obtained free of charge from the British Standards Institution, British Standards House, 2, Park Street, London, W.1. This list, which classifies the products into categories, details as far as is possible the extent of the range of equipment covered, together with the firm's approval number and full name and address. Apart from the nineteen sections in which the majority of equipment is classified, there is a large miscellaneous section which includes such diverse products as welding equipment, electric lighting plants, cathode ray oscilloscopes, moulding presses, hydro-extractors and textile machinery. Full information on the B.S.I./CSA Approvals Agency is given in a booklet (ref. PD.1533), obtainable from the B.S.I., price 3s. 6d. post free.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—The annual dinner of the Faraday House Old Students' Association was held at the Savoy Hotel on Thursday, October 29th, under the chairmanship of Mr. A. N. Irens, president of the Association. During the after-dinner speeches references were made to various aspects of technical education. Mr. H. Bishop, president of the Institution of Electrical Engineers, who proposed the toast of "Faraday House," expressed approval of the higher standard of the Faraday House entrance examination and spoke of the changes to the sandwich course to suit present-day requirements. Dr. W. R. C. Coode Adams, the principal, in his response to the toast, referred to these changes and, in particular, to the proposed three-part academic course in college. He spoke of the dilemma that faced those who wanted more science graduates at a time when examination standards were being raised, with the result that a smaller percentage of candidates might be expected to pass. Moreover, there was a serious shortage of science masters.

SECTIONAL MEETING OF WORLD POWER CONFERENCE.—Particulars have been announced of the eleven papers which are to be presented by British delegates to the sectional meeting of the World Power Conference in Rio-de-Janeiro, Brazil, from July 25 to August 8, 1954. It is expected that the technical sessions of the conference will take place in the first week, with visits to neighbouring hydro-electric and thermal power stations in the second week. The eleven British papers are as follows: "Integration of Hydro and Thermal-Electric Power in Great Britain," by J. D. Peattie and A. A. Fulton; "Economic Aspects of the Utilisation and Design of Wind Power Plants," by E. W. Golding; "Special Refinery Equipment for Tropical and Sub-Tropical Areas," by E. le Q. Herbert; "The Production and Refining of Shale Oil," by G. H. Smith and D. Stewart; "British Developments in Gas Turbines," comprising "Introduction," by Sir Harold Roxbee Cox, "Gas Turbines for Use on Land and Sea," by A. T. Bowden and R. J. Welsh, and "Gas Turbines for Aviation," by Professor W. R. Hawthorne; "Carbonisation and Gasification in Tropical and Sub-Tropical Regions," by John F. West; "Boiler Design and Availability," by W. F. Simonson; "Application of Power to Agriculture," by W. H. Cashmore and H. J. Hamblin; "Possible Thermal Cycles for Power Generation, including Mixed Cycles," by Professor O. A. Saunders; "Combustion of Vegetable Wastes in Relation to Power Production," by A. Parker and T. F. Hurley; and "The Design of Electrical Equipment for Use in Tropical Climates," contributed by members of the British Electrical and Allied Manufacturers' Association.

Contracts

HILLS (WEST BROMWICH), Ltd., has received a contract for a two-storey school in Toronto, valued at 300,000 dollars. The prefabricated steelwork and windows for this school, to the value of 60,000 dollars, were despatched three weeks from the receipt of the order, and key erectors from Hills (West Bromwich), Ltd., are being flown out to Canada to supervise the erection.

CONTRACTS have been placed by the British Electricity Authority during the past month for power stations, transforming stations, and transmission lines amounting in the aggregate to £13,359,118. The principal contracts include:—Hackney "B" power station, cladding for turbine, switch, boiler and precipitator houses and coaling tower (J. L. Keir and Co., Ltd.); East Yelland power station, near Barnstaple, four 180,000 lb per hour boilers (John Thompson Water Tube Boilers, Ltd.); Portishead "B" power station, near Bristol, two 300,000 lb per hour boilers (Mitchell Engineering, Ltd.) and ash settling pits and return water pump house (John Laing and Son, Ltd.); Goldington power station Bedford, one 300,000 lb per hour boiler (Clarke, Chapman and Co., Ltd.); Tilbury "A" power station, superstructures (Walter Lawrence and Son, Ltd.); Willington "A" power station, near Derby, two 830,000 lb per hour boilers (International Combustion, Ltd.) and two 100MW turbo-generators, condensing and feed heating plant, one 120MVA generator transformer, and two 15MVA transformers (English Electric Company, Ltd.); Meaford "B" power station, Stone, Staffs, high-pressure piping equipment (Babcock and Wilcox, Ltd.); Bold "A" power station, St. Helens, main foundations (John Laing and Son, Ltd.) and steel frame for turbine and boiler-houses (Dorman Long and Co., Ltd.); Ferrybridge "B" power station, Yorks, main foundations (George Wimpey and Co., Ltd.), and ash and dust handling plant for No. 1 boiler (B.V.C. Industrial Constructions, Ltd.); Portobello power station, Edinburgh, high-pressure pipework and valves (Aiton and Co., Ltd.); Barony power station, Ayr, four 150,000 lb per hour boilers (Babcock and Wilcox, Ltd.); and Dudley, Worcs, 132kV double-circuit overhead line (British Insulated Callender's Construction Company, Ltd.).

Personal and Business

MR. J. HOLMES has been appointed sales manager of Thos. Storey (Engineers), Ltd., Stockport.

MR. C. F. MERRIAM, chairman of the British Xylonite Company, Ltd., has been elected president of the British Plastics Federation.

BROOK MOTORS, Ltd., Huddersfield, has established an American company, in Chicago, under the title of Brook Motor Corporation.

MR. T. W. N. JAMESON, Mr. D. R. W. WATTS and Mr. R. B. SMITH have been appointed to the board of George Wimpey and Co., Ltd.

REAR ADMIRAL G. C. ROSS, C.B., until recently Director of Maintenance and Repair at the Admiralty, has joined Armstrong Siddeley Motors, Ltd., Coventry.

THE HOYT METAL COMPANY OF GREAT BRITAIN, Ltd., announces the establishment of a subsidiary entitled Hoyt Alloys and Chemicals of Australasia Pty., Ltd., 82, Pitt Street, Sydney, N.S.W.

WICKMAN, Ltd., Coventry, announces the opening of a London branch factory and offices at Oxgate Lane, Cricklewood, N.W.2. The company's London area office and export department have been transferred to that address.

THE GENERAL ELECTRIC COMPANY, Ltd., announces the appointment of Mr. H. W. Wilson as an assistant to Mr. W. J. Bird, the London sales manager. Mr. Wilson has been manager of the company's Southampton branch since 1938, in which appointment he is succeeded by Mr. D. E. Kidner.

MR. J. W. C. HEDGES, assistant chief engineer, special traffics (Pickfords) division, British Road Services, has been re-elected chairman of the Institute of Road Transport Engineers. Mr. J. K. Bennett has been appointed secretary of the Institute, in succession to Mr. C. D. Morgan, who has become secretary of the British Road Federation.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., and British-Insulated Callender's Cables, Ltd., state that arrangements have been made by which Metropolitan-Vickers has taken over, from November 2nd, the manufacture, sale and servicing of resistance welding and heating machines formerly manufactured by British Insulated Callender's Cables, Ltd.

NORTHERN ALUMINIUM COMPANY, Ltd., Banbury, announces the following changes in its sales department: Mr. F. Layton takes charge of the sales administration department at Banbury and is succeeded as manager of the Leeds area sales office by Mr. H. M. Louch; Mr. E. D. Iliff, at present publicity manager, is to succeed Mr. Louch as sales development manager, and Mr. R. F. Tayler will have charge of the publicity division.

British Patent Specifications

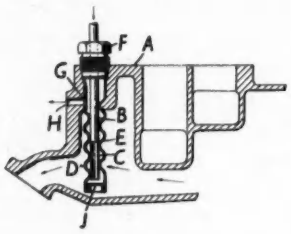
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2 2s. 8d. each.

INTERNAL COMBUSTION ENGINES

698,224. December 7, 1951.—THERMALLY ACTUATED CHOKES FOR INTERNAL COMBUSTION ENGINES, Ford Motor Company, Ltd., 88, Regent Street, London, W.1.

In the drawing the engine manifold is indicated at *A*, and the flow of the exhaust gas through the manifold is indicated by the arrows. An air heater *B* secured in the manifold is immersed in the exhaust gas stream and is heated by it. It comprises a central tube *C* surrounded by shell *D* which has helical convolutions *E*. The central tube and shell are secured in place by a nut *F* screwed in the manifold.



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The upper portion of shell *D* is provided with an opening *G* which is aligned with hole *H* in the manifold. The shell is closed at the bottom by a cap *J* and its central tube and cap are all fabricated from Inconel, a stainless steel or other metal resistant to the combined effects of heat, lead compounds and oxidation. The air destined to be used to actuate the automatic choke thermal element is withdrawn from the air cleaner (not shown) and enters central tube *C* from above as shown by the arrow. This air flows axially downwardly through the tube and then flows upwards around helical convolutions *E*, and leaves the heater through opening *G* and hole *H* and then passes to the thermal element of the automatic choke.—*October* 7, 1953.

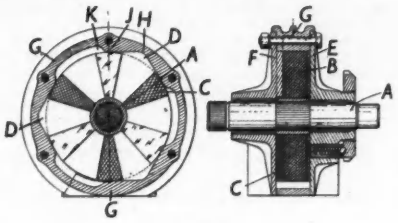
698,026. February 15, 1952.—AIR-COOLED TWO-STROKE ENGINES, Porsche Konstruktionen G.m.b.H., Schwieberdinger Strasse 141, Stuttgart-Zuffenhausen, Germany.

The object of the invention is to provide an internal combustion engine as compact as possible. The air-cooled, two-stroke internal combustion engine described has a scavenging piston pump arranged in parallel with the cylinder. This short-stroke scavenging pump is arranged completely in the crank casing and closed by a cover provided with a support to carry the blower of cooling air. The diameter of the scavenging piston is 1·4 to 1·8 times that of the working piston. The dynamo is built in the hub of the blower and the blower shaft forms the dynamo shaft, so that the blower and dynamo are mounted on the support of the cooling blower. Drive of the blower is effected by a belt pulley which rotates at a higher speed than the crankshaft. The crankpin for the connecting-rod of the scavenging pump overhangs and its counterweight and a driving pinion for the auxiliary drives are in one forged piece.—*October* 7, 1953.

POWER TRANSMISSION

698,208. April 3, 1951.—OSCILLATION DAMPER, Charles Granet and Georges Roland, 17 rue d'Essling à Courbevoie (Seine), France.

An object of the invention is to provide an adjustable damper capable of working progressively in either direction of rotation to damp any vehicle oscillations. The drawings show a damper in which progressive action is obtained circumferentially. Integral with a shaft *A* coupled with the member the oscillations of which have to be damped, the rubber rotor *B* has on one of its lateral faces projections *C*, and on its periphery bosses *D* the axes of which are 120 deg. spaced one from the other. The bosses *C* are the seat of the friction forces between the rotor *B* and the outer stator, whereas the projections *C* serve to limit the angular displacement of the rotor with respect to the stator. The stator is composed of two end shields *E* and *F* joined together by a rim *G* and assembled by means of bolts. This rim is provided on its inner surface with recesses and protuberances symmetrically arranged according to three axes which are 120 deg. spaced one from another. At rest each boss *D* of the rotor *B* is located in a stator or brake recess *H*. This recess is very wide angled and has sides which are thus slightly inclined towards the centre line of the apparatus and attain crests corresponding with the rotor radius. At the other side of each crest *J* the inside surface of the stator slopes steeply away from the centre line of the apparatus, so as to form a recess *K* of uniform depth which every boss of the rotor can engage without being compressed. The recess *K* may be called an escape recess. When the damper is at rest each boss *D* of rotor *B* is located in a recess *H*. In whatever direction the oscillation is to be damped, the rotation of the rotor compels boss *D* to compress progressively since the volume assigned to it becomes progressively smaller and smaller; the friction forces acting on one of the slopes moving from *H* to *J* thus increase until they reach a maximum corresponding to the



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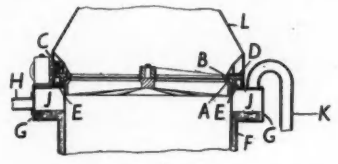
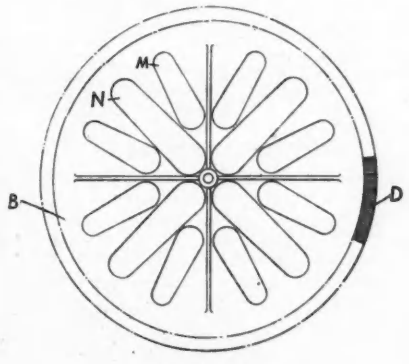
passage of the crest *J*, after which each boss *D* recovers rapidly its undeformed shape in the recess *K*. As oscillations are concerned, shaft *A* is immediately compelled to rotate in the opposite direction, so that boss *D* is bound to compress rapidly due to the steep slope between recess *K* and crest *J*, and further on to relax slowly until the neutral state corresponding to the balance position is attained. Friction being directly proportional to the compression of the boss, in whatever direction the oscillation is to be damped, the damper brakes progressively during the forward stroke and abruptly during the return stroke. The damper described is provided with means for permitting limitation of the angular action of the rotor with respect to the stator if desired, and other modified constructions are also shown in the specification.—*October* 7, 1953.

GAS PRODUCERS

696,682. August 14, 1950.—IMPROVEMENTS IN GAS PRODUCERS, Reginald Vandezee Farnham, 15, Mount Ephraim Road, formerly of 17, Guildford Road, Tunbridge Wells.

The object of the invention is to provide fuel feeding arrangements for gas producers, whereby a fuel bed of substantially uniform thickness throughout may be obtained and in which the rate of fuel feed is automatically determined in accordance with the load demand. As shown in the drawing, the usual fuel feed arrangement at the top of the producer shell and the water jacket at the top of the casing are dispensed with. Fitted in their place is a fixed plate *A* with openings distributed over its area. The openings may take the form of holes and/or slots. Above the plate is a rotatable plate *B* having similar





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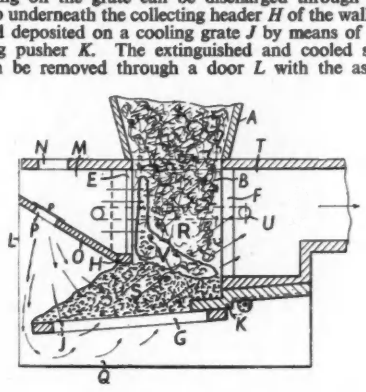
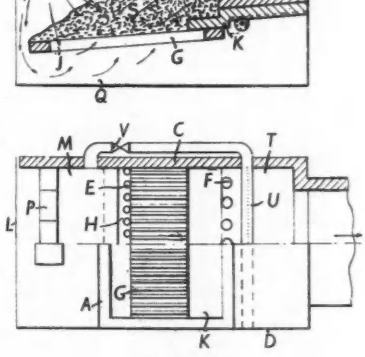
openings to the upper plate and being rotated by a motor-driven pinion *C* engaging an externally toothed ring *D* on the plate. The plate *B* is mounted on rollers *E* at the periphery. The upper ends of the water jacket walls *F* of the shell are enlarged in diameter at *G* to compensate for the area of the central water jacket dispensed with. Air is admitted at *H* to the steam space *J* and the air and steam are led by a pipe or pipes *K* to the lower end of the producer into contact with the fuel bed. A gas outlet is provided in the wall of the shell beneath the perforated plates. Also provided is a shutter which is intermittently operated in accordance with the fuel feed to close and open the feed passage to the hopper *L* so as to prevent loss of gas through the passage. In operation, solid fuel particles are supplied continuously by way of the hopper so as to rest upon the plate *B* which is conveniently rotated at, say, 4 r.p.m. The lower view shows the form of the rotating top plate *B* furnished with cross ribs and two series of openings *M* and *N*, arranged radially and tapering so as to be narrower towards the periphery where the speed is greater than at the centre. A modified design of plate is also shown in the specification.—*September* 9, 1953.

FURNACES

698,097. January 1, 1951.—THE FIRING OF COKE AND OTHER FUELS, De Directie van de Staatsmijnen in Limburg, 2 van der Maesenstraat, Heerlen, The Netherlands.

The invention is intended to provide a method and installation in which even coke of a size of 0·8in to 4·8in can be fired with high efficiency and which reduces liability to extinguish in the case of a banked or slow fire. As the drawings show, from the bunker *A* the fuel gravitates into the combustion chamber *B*. The combustion chamber is located between the walls *C* and *D* of the furnace installation and between two apertured side walls *E* and *F* formed by water-cooled vertical pipes, the lower ends of which open into a collecting tank. The bottom of the combustion chamber consists of a grate *G*. The wall *E* is not so deep as the wall *F*, and slag accumulating on the grate can be discharged through the gap underneath the collecting header *H* of the wall *E*, and deposited on a cooling grate *J* by means of the slag pusher *K*. The extinguished and cooled slag can be removed through a door *L* with the ashes





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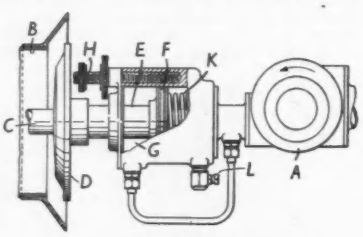
in the pit under the grate. The combustion air is injected into an air distribution box *M* through the aperture *N*. From this compartment, adjoining the wall *E*, the air passes between the pipes and travels horizontally through the fuel bed. The bottom *O* of the distribution box is apertured at *P*. Part of the air entering the distribution box flows through this aperture into the ashpit *Q* from where it ascends in a generally diagonal direction through the combustion residue and the overlying fuel. The ratio between the two amounts of primary air may be controlled by regulating either the size of aperture *P* by means of a slide valve or the position of an element in the distribution box in front of the wall *E*. If the primary air be exclusively supplied in a horizontal direction, the combustion zone will be formed along the wall *E*. Consequently, the temperature in the combustion chamber and, hence, also the slag temperature, will decrease towards the wall *F*. As a result pieces of fuel deposited near the wall *F* will be enclosed by the slag and are wasted, while compact slag agglomerations are formed which are difficult to remove. The diagonal current of additional air causes the formation of another and substantially horizontal combustion zone on the slag bed *S*. Consequently, the combustion zone in the furnace, according to the invention, will be of the form indicated by *V* (upper diagram). The extension of the grate *J* below the distribution box *M* permits of the slag removed from the bottom of the combus-

tion chamber being cooled by part of the primary air and of that part of the primary air being preheated by the hot slag before entering the combustion chamber, in addition to giving any fuel which may be present in the slag on the extended portion of the grate the opportunity to react with the combustion air. The term combustion zone as used in the present application refers to the zone where the fuel is completely burned. The CO_2 produced in the combustion zone passes through the glowing fuel bed between combustion zone and the wall *F*. In this zone, the gas is reduced to CO. Subsequently, this gas passes through the apertures in the wall *F* into the compartment *T*, where it is mixed with secondary air and oxidised to CO_2. The secondary air is introduced into the compartment *T* through a pipe *U* connected with the distribution box for the combustion air, and provided with small apertures through which the air enters the compartment. By means of a control valve *V* (lower diagram), the ratio between the amounts of primary and secondary air may be so adjusted that the flue gases, which are ultimately discharged through the stack, are substantially free from combustible gases.—*October* 7, 1953.

BURNERS AND SPRAYERS

698,172. February 18, 1949. OIL-BURNING EQUIPMENT, Christopher Shorrock, "Moorlands," Garstang Road, Preston, Lancashire.

In the drawing is shown a pneumatically controlled form of damper operator. An oil burner nozzle of the low-pressure type is supplied with primary air by a rotary compressor *A* and is arranged centrally at the end of a tubular duct *B* through which secondary air is induced to flow. A nozzle tube *C* central in the duct *B* leads fuel and primary air from the compressor to the burner, the compressor being located at some distance behind the rear end of the duct. A damper or sealing member *D* is carried by one end



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of a tubular slide *E* which is mounted on the tube *C*. The other end of the slide carries a piston *F* which operates in a closed pneumatic cylinder *G*. A bolt *H* fitted with a lock nut screwed into a boss provides an adjustable stop for the rearward or opening movement of the damper. A compression spring *K* mounted in the outer end of the cylinder behind the piston urges the piston, tubular slide and damper towards the closed position. Air for operating the piston in the opposite or opening direction is led to the other end of the cylinder through a pipe as shown from the compressor discharge. A small adjustable air bleed valve *L* is connected to the cylinder space at the rear of the piston, regulation of this valve determining the rate of air displacement from the cylinder during the damper opening cycle and therefore the actual rate of the damper opening movement. This valve is provided with a simple one-way auxiliary suction valve which operates only upon the return closing cycle of the damper, thus allowing a rapid and unrestricted closing of the damper.—*October* 7, 1953.

Launches and Trial Trips

ROYALGATE, coaster ; built by the Goole Shipbuilding and Repairing Company, Ltd., for the Hullgates Shipping Company, Ltd.; length 175ft, breadth 27ft 6in, depth 11ft 6in, deadweight 700 tons ; British Polar diesel engine, 545 b.h.p. at 300 r.p.m. Trial, October 1st.

WILLIAM JERSEN, oil tanker ; built by Swan, Hunter and Wigham Richardson, Ltd., for A/R Caloric, Bergen ; length between perpendiculars 535ft, breadth moulded 73ft, depth moulded 38ft 10in, deadweight 18,000 tons, summer draught 31ft 10in ; twenty-seven cargo oil tanks, two pump rooms, three 500 tons per hour cargo oil pumps, steam deck machinery, two 200kW diesel-driven generators, one 9kW steam-driven generator, two Scotch boilers ; Swan, Hunter - Doxford opposed-piston oil engine, six cylinders, 725mm diameter by 2250mm combined stroke, 7500 b.h.p. at 115 r.p.m. Trial, October 8th.

FLEETBANK, cargo ship ; built by Harland and Wolff, Ltd., for the Andrew Weir Shipping and Trading Company, Ltd.; length between perpendiculars 425ft, breadth moulded 59ft, depth moulded to shelter deck 38ft 3in, gross tonnage 5800 ; two complete steel decks, eight watertight compartments, four main cargo holds, three 175kW diesel-driven generators, two vertical boilers ; Harland-B. and W. two-stroke, single-acting, opposed-piston diesel engine, six cylinders, 620mm diameter by 1870mm combined stroke. Trials, October 14th.

TANTALLON CASTLE, cargo ship ; built by Harland and Wolff, Ltd., for the Union Castle Line ; length between perpendiculars 465ft, breadth moulded 65ft 6in, depth moulded to shelter deck 41ft 6in., gross tonnage 7450 ; two complete steel decks, nine watertight compartments, five main cargo holds, derrick complement includes one 80-ton and two 30-ton derricks, three 250kW diesel-driven generators ; Harland and Wolff double-acting, two-cycle diesel engine, eight cylinders, 620mm diameter by 1400mm stroke. Launch, October 22nd.

JARANDA, oil tanker ; built by Harland and Wolff, Ltd., for Anders Jahre and Co., Norway ; length between perpendiculars 540ft, breadth moulded 73ft, depth moulded 39ft 3in, deadweight 18,500 tons ; two 75kW steam-driven generators, one 75kW diesel-driven generator, two single-ended multitubular cylindrical boilers ; Harland and Wolff - B. and W. single-acting, two-cycle diesel engine, six cylinders, 750mm diameter by 2000mm combined stroke, 114 r.p.m. Launch, October 23rd.

PATHFINDER, survey ship ; built by J. Samuel White and Co., Ltd., Cowes, for the Crown Agents for the Colonies ; length between perpendiculars 150ft, breadth moulded 27ft 6in, depth moulded 12ft, draught loaded 10ft, deadweight 340 tons, trial speed 11½ knots ; two 20kW steam-driven generators, one 10kW diesel-driven generator ; two triple-expansion steam engines, cylinder diameters 10½in by 17½in by 27½in by 18in stroke, 350 i.h.p. at 150 r.p.m.; one cylindrical return tube oil-fired boiler, working pressure 200 lb per square inch. Launch, October 23rd.

SUNBRAYTON, bauxite ore and oil carrier ; built by the Burntisland Shipbuilding Company, Ltd., for Saguenay Terminals, Ltd., Montreal, Canada ; length overall 442ft, breadth moulded 60ft 6in, depth moulded 29ft 6in, deadweight 7850 tons, draught loaded 20ft ; steam deck machinery, two 60kW, steam-driven generators, one 32kW diesel-driven generator ; Rankin and Blackmore triple-expansion steam engine, cylinder diameters 22in by 38in by 63in by 42in stroke, steam supplied at 220 lb per square inch by two oil-fired Scotch boilers. Launch, October 23rd.

DEVONBROOK, short sea trader ; built by John Lewis and Sons, Ltd., for the Williamstown Shipping Company, Ltd.; length between perpendiculars 2 5ft, breadth moulded 35ft 6in, depth moulded to upper deck 15ft 9in, deadweight 1600 tons ; three holds ; triple-expansion engine, 16½in by 28½in by 47in diameter cylinders by 30in stroke, two oil-fired Scotch boilers. Launch, October 24th.

OCTAVIAN, oil tanker ; built by Swan, Hunter and Wigham Richardson, Ltd., for Mr. Hilmar Reksten, Bergen ; length between perpendiculars 625ft, breadth moulded 86ft, depth moulded 46ft, deadweight 34,000 tons on 34ft 6in draught, service speed 14½ knots ; thirty-three cargo oil tanks, two pump rooms, four 500 tons per hour horizontal duplex steam cargo pumps, two stripping pumps, steam deck machinery, three multitubular Scotch boilers, two 280kW diesel-driven generators, one 150kW and one 60kW steam-driven, generators ; two Wallsend-Doxford opposed-piston, two-stroke, oil engines ; each has five cylinders, 670mm diameter by 2320mm combined stroke, total of 11,000 b.h.p. at 116 r.p.m. Launch, October 26th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Nov. 11th.—LONDON SECTION : School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, "A High-Definition General-Purpose Radar," J. W. Jenkins, J. H. Evans, G. A. G. Wallace and D. Chambers, 6.30 p.m.——N.E. SECTION : Institution of Mining and Mechanical Engineers, Newcastle upon Tyne, "Principles of Electronic Computing Machines," B. V. Bowden, 6 p.m.

ELECTRIC RAILWAY SOCIETY

Mon., Nov. 9th.—DUNDEE BRANCH : Mathers Hotel, Dundee, "Hydraulics as Applied to Machine Tools," T. Ransome, 7.30 p.m.

ENGINEERS' GUILD

Thurs., Nov. 12th.—Caxton Hall, Westminster, London, S.W.1, "The Engineers' Guild : Its Purpose and Value," Henry Nimmo, G. E. M. Godfrey and R. W. H. Couzens, 6 p.m.

ILLUMINATING ENGINEERING SOCIETY

Tues., Nov. 10th.—Welcome Research Institution, Euston Road, London, N.W.1, "Application of Fluorescent Dimming Circuits," H. H. Ballin and W. J. Vine, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Nov. 10th.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, "Illumination and Factory Lighting," 7.15 p.m.
Wed., Nov. 11th.—E. MIDLANDS BRANCH : Gas Board Showrooms, Parliament Street, Nottingham, "An Introduction to Cost and Works Accounting for the Works Engineer," S. H. Alloway, 7 p.m.
Thurs., Nov. 12th.—N.E. BRANCH : Roadway House, Oxford Street, Newcastle upon Tyne, "Manufacture of Ball Bearings," L. B. Jack, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Nov. 11th.—LONDON BRANCH : Waldorf Hotel, London, W.C.2, "Pattern-Making and Storage," A. Talbot, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Nov. 10th.—85, Minories, London, E.C.3, "The Resistance to Failure of Condenser and Heat Exchanger Tubes in Marine Service," P. T. Gilbert, 5.30 p.m.
Thurs., Nov. 12th.—JUNIOR LECTURE : Technical College, Bolton "Marine Diesel Engines," A. G. Arnold, 3 p.m.

INSTITUTE OF PETROLEUM

Wed., Nov. 11th.—Manson House, Portland Place, London, W.1, "Paint in the Petroleum Industry," H. B. Footner, 5.30 p.m.

INSTITUTE OF WELDING

Thurs., Nov. 12th.—S. LONDON BRANCH : 2, Savoy Hill, W.C.2, Film Meeting, 6.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Tues., Nov. 10th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "The Control and Removal of Surplus Water in the Soil," Turner Cooper, 2.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Wed., Nov. 11th.—MIDLANDS BRANCH : The University, Edmund Street, Birmingham, "Perforated Plates in Liquid-Liquid Extraction (Toluene-Diethylamine-Water System)," F. H. Garner, S. R. M. Ellis and D. W. Fosbury, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

To-day, Nov. 6th.—N.W. ASSOCIATION : Engineers' Club, Albert Square, Manchester, "The Control of Water for Food Production," H. Addison, 6.30 p.m.
Tues., Nov. 10th.—PUBLIC HEALTH MEETING : Great George Street, Westminster, London, S.W.1, "Atmospheric Pollution : Causes, Effects and Prevention," Albert Parker, 5.30 p.m.
Thurs., Nov. 12th.—MIDLANDS ASSOCIATION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Experimental Structural Research and Design Methods," A. J. S. Pippard, 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Nov. 9th.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on "What are the Requirements of Electrical Engineering Textbooks," opened by D. K. McCleery, 6 p.m.
Tues., Nov. 10th.—LONDON STUDENTS' SECTION : R.E.M.E. Depot, Arborfield, Berks, "Scanning Generators," M. J. Wyatt and P. D. Gibbons, 7 p.m.
Wed., Nov. 11th.—RADIO SECTION : Savoy Place, London, W.C.2, "Some Aspects of the Design of V.H.F. Mobile Radio Systems," E. P. Fairbairn, 5.30 p.m.
Thurs., Nov. 12th.—EXTRA MEETING : Savoy Place, London, W.C.2, Discussion on "Safety Precautions in Electronic Apparatus, with particular reference to Medical Applications," opened by H. W. Swann and H. W. Shipton, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Nov. 6th.—GENERAL MEETING : Storey's Gate, St. James's Park, London, S.W.1, "Present Trends in Surge Tank Design," C. Jaeger, 5.30 p.m.
Tues., Nov. 10th.—AUTOMOBILE DIVISION : Storey's Gate, St. James's Park, London, S.W.1, "Problems in the Design of an Economical Automobile Transmission," T. C. F. Stott, 5.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Sat., Nov. 7th.—COVENTRY SECTION : Visit to Alfred Herbert, Ltd., Threading Factory, Black Horse Lane, Exhall, Coventry, 9.30 a.m.
Wed., Nov. 11th.—PRESTON SECTION : Victoria and Station Hotel, Preston, "Developments in the Use of Automatic Lathes," H. R. Adcock, 7.15 p.m.——SOUTHERN SECTION : Municipal College Annexe, Portsmouth, "Practical Application of Tungsten," F. H. Bates, 7 p.m.
Thurs., Nov. 12th.—CORNWALL SECTION : School of Mines, Camborne, "Drop Forging and Stamping," A. J. White, 7.15 p.m.——COVENTRY SECTION : Geisha Cafe, Hertford Street, Coventry, "The Activities of P.E.R.A.," D. F. Galloway, 7 p.m.——LEICESTER AND DISTRICT : Balmoral Room, Bell Hotel, Leicester, "Production Management's Responsibility for Production," B. H. Dyson, 7 p.m.——READING SECTION : Great Western Hotel, Reading, "Effective Tooling for Production," B. Holloway, 7.30 p.m.
Fri., Nov. 13th.—W. WALES SECTION : Central Public Library, Alexandra Road, Swansea, "Noise and Vibration in Machinery," W. A. Tuplin, 7 p.m.——E. COUNTIES SECTION : Diocesan Hall, Tower Street, Ipswich, "Transport for an Engineering Works," E. N. Farrar, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Nov. 10th.—MIDLAND COUNTIES BRANCH : Supper Room, The King's Hall, Queen Street, Derby, "Tubular Structures," E. McMinn, 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 6th.—Alliance Hall, Palmer Street, London, S.W.1, "Peak Loads and Heat Storage," W. Goldstern, 7 p.m.
Mon., Nov. 9th.—Livesey Clegg House, Sheffield, "Some Engineering Aspects of Water Supply," P. J. Noel Wood, 7.30 p.m.
Fri., Nov. 13th.—ORDINARY MEETING : Townsend House, Greycoat Place, London, S.W.1, "Post-War Ship Design and the Future," C. A. Hobson, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Nov. 13th.—Engineers' Club, Albert Square, Manchester, "Modern Application of Reinforced Concrete to Industrial Buildings," M. B. Watson, 6.45 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Nov. 6th.—Mining Institute, Newcastle upon Tyne, "The Influence of Thermal Effects on the Manœuvrability of Marine Turbine Machinery," P. J. Terrell, 6.15 p.m.
Fri., Nov. 13th.—Mining Institute, Newcastle upon Tyne, "Some Observations from 16in Propeller Tests in the New King's College Cavitation Tunnel," L. C. Burrill and Arnold Emerson, 6.15 p.m.

ROYAL AERONAUTICAL SOCIETY

Tues., Nov. 10th.—SECTION LECTURE : The Library, 4, Hamilton Place, London, W.1, "Gusts and their Measurement," J. Taylor, 7 p.m.
Thurs., Nov. 12th.—MAIN LECTURE : Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, "Stability and Control in Aircraft Design," I. C. Wimpenny, 5.30 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., Nov. 9th.—12, Great George Street, London, S.W.1, Presidential Address, G. A. Coombe, 5.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Fri., Nov. 13th.—CORROSION GROUP : Institution of Electrical Engineers, Savoy Place, London, W.C.2, "A Symposium on Cathodic Protection," 9.45 a.m.

SOCIETY OF INDUSTRIAL ENGINEERS

Wed., Nov. 11th.—Old Nag's Head Hotel, Manchester, "Method Study : A Technique of Work Study," E. Hollinghurst, 6.30 p.m.